SECTION 1001 MATERIAL SOURCES:

1001-1 Description:

The work under this section shall consist of the procuring of borrow, subbase and base materials, mineral aggregates for concrete structures, and mineral aggregates for surfacing materials specified for use from sources either designated on the project plans or in the Special Provisions or from other sources.

1001-2 General:

The contractor shall determine for itself the type of equipment and work required to produce a material meeting the specifications.

Unless otherwise specified, pits and quarries shall be so excavated that water will not collect and stand therein. Sites from which material has been removed shall, upon completion of the work, be left in a neat and presentable condition. Where practicable, borrow pits, gravel pits, and quarry sites shall be located so that they will not be visible from the highway.

The contractor shall provide an environmental analysis, as specified in Subsection 104.12, for any contractor-furnished source proposed for use. Environmental analyses prepared for contractor-furnished sources, and approved by the Department later than January 1, 1999, will be acceptable.

A list of sources known by the Department to have approved environmental analyses will be kept on file at the ADOT Materials Group, mail drop 068R, 1221 N. 21st Avenue, Phoenix, Arizona 85009-3740. The contractor may propose the use of these sources as a contractor-furnished source without the requirement of submitting a new Environmental Analysis, provided that all other requirements of this section have been met.

It shall be the responsibility of prospective bidders to conduct any necessary on-site investigations and/or explorations, and to satisfy themselves that the quantity and/or quality of material exists in the sources listed above. No representation regarding quality or quantity of materials is made by the Department.

1001-2.01 Definitions:

All material sources shall fall into one of the following two categories:

Department-Furnished Source
Contractor-Furnished Source

A Department-furnished source shall be defined as a material source for which the Department has prospected, taken samples, tested, prepared an Environmental Analysis, secured the rights for its use, including ingress and egress, and which may be available for the contractor's use on a specific project.

A contractor-furnished source shall be defined as any source other than a Department-furnished source, and shall include commercial operations as defined below.

A commercial operation shall be defined as a material source at which the owner or producer has been located for at least the preceding 12 months prior to award of contract, and routinely engaged during regular business hours on a consistent basis in the processing and selling of sand, rock, ready mixed Portland cement concrete, asphaltic concrete and other similar products to all parties. The company shall have an Arizona retail sales tax license. The contractor shall furnish documentation to the Engineer that the source is an active commercial operation. This documentation may include evidence of sales or other data acceptable to the Engineer. A commercial source, whenever referenced in the specifications, shall be considered to be a commercial operation, as defined herein.

Should the contractor elect to set up a concrete or asphalt batch plant within or adjacent to a commercial operation for the exclusive supply of contract items, the contractor's operation shall not be considered part of the commercial operation.

1001-2.02 Material Sources in Flood Plains:

The use of material sources situated in the 100-year flood plain of any stream or watercourse, and located within one mile upstream and two miles downstream of any highway structure or surfaced roadway crossing, shall be limited as follows:

(A) Existing commercial operations, as defined in Subsection 1001-2, shall not be utilized as a source of borrow.

(B) No new source or existing non-commercial source will be approved for any materials except as specified in the following subparagraph (C).

(C) Surplus material from agency-administered flood control management projects may be used as borrow material only if the contractor submits written evidence to the Engineer that the flood control agency project was fully designed and funded prior to the date of advertisement for bids on the Department project.

(D) Material sources located on Native American Indian Reservations will be considered for use based on an individual analysis. The analysis shall include a review of applicable land use plans, flood plain management plans, environmental plans, applicable laws and regulations pertaining to Indian Reservations, and an engineering analysis of the effects on any highway facility or structure. The contractor shall obtain from the Native American Tribal Council all permits, licenses, and approvals and present to the Department for review. The Department will review each request on a case by case basis.

The location of any new material source or existing non-commercial material source proposed for use on the project shall be reviewed by the appropriate agency having flood plain management jurisdiction for the area in which the proposed source is located. The contractor shall obtain a letter from the agency

addressed to the Engineer certifying that the location of the proposed source conforms to the requirements of the specifications.

Contractors seeking a flood plain material source are cautioned that Section 404 of the Clean Water Act may prevent use of the source unless an appropriate permit is first obtained from the U.S. Army Corps of Engineers.

If a flood plain source is being considered for use, the contractor is advised to contact Environmental Planning Services of ADOT to insure that the source will be obtainable within the required time frame.

1001-3 Department-Furnished Sources:

1001-3.01 General:

The use of a Department-furnished source is not mandatory.

1001-3.02 Information Available:

The approximate location, the kind of material, the name and address of the owner, the amount of royalty charges, and other relevant information will be available for review from the Materials Group, 1221 N. 21st Avenue, Phoenix, Arizona 85009-3740.

The available information should be considered at most as only a starting point for those prospective bidders choosing to use the source.

It shall be the responsibility of prospective bidders to conduct any necessary on-site investigations and/or explorations, and to satisfy themselves that the quantity and/or quality of material exists in the source in the event their bids are predicated upon the use of the source. Whether a source will in fact yield material of sufficient quantity or quality to meet the specific requirements may not have been determined.

Prospective bidders are advised that an agency having jurisdiction over the source, such as the Forest Service, Bureau of Land Management, Bureau of Reclamation, the State Land Department, etc., or the owner, as a condition to the use of the source, may have imposed certain obligations. The contractor who uses such a source shall assume full contractual responsibility for any and all of these obligations imposed either by the agency having jurisdiction or by the owner. Specific requirements may or may not be available, and prospective bidders considering such a source are urged to make themselves fully aware of any and all requirements.

It shall be the responsibility of the bidder to ensure that the Environmental Analysis complies with existing laws, rules, and regulations.

1001-3.03 Usage of Materials:

Except as hereinafter provided, materials removed from Department-furnished sources shall be used only for the specific project and purpose for which the source was obtained.

Should the contractor desire to remove and use material other than that specified for use, prior approval by means of a supplemental agreement shall be obtained. The contractor shall furnish the Engineer with evidence that the owner of the source has agreed to such use. The Department reserves the right to disapprove any request when it is considered to be in the best interest of the Department to conserve such material for future use.

If the Department approves the removal and use of such material, the quantity of the material removed and the quantity of any waste material resulting from its removal will be deducted from the estimated quantity of material shown to be available.

1001-3.04 Royalty Charges:

The amount of the royalty charges and the name and address of the party to whom royalties are to be paid will be available from the Materials Group, 1221 N. 21st Avenue, Phoenix, Arizona 85009-3740.

Prior to the time of final payment, the contractor shall furnish the Engineer with evidence such as an endorsed canceled check that all royalty charges have been paid. In the event that royalty charges have not been paid, the Department reserves the right to make such payment and to deduct the amount of such payment from monies due the contractor.

The final billing and payment for material extracted from sources under the jurisdiction of the State Land Department will include a small administrative charge based on the total amount of royalties due for materials removed.

Upon receipt of the final billing from the Department of Transportation, the contractor shall mail a check, payable to the State Land Department, addressed as follows:

Arizona Department of Transportation
Field Reports Services
206 South 17th Avenue
Phoenix, Arizona 85007

1001-3.05 Performance Bonds:

If Department-furnished sources are under the jurisdiction of either the State Land Department or the Bureau of Land Management, the contractor shall secure a performance bond. A fully executed copy of the bond shall be furnished the Engineer along with evidence that a fully executed copy has been sent to the State Land Department or the Bureau of Land Management.

The form of the Performance Bond will be included in the proposal pamphlet. For pits under the jurisdiction of the Bureau of Land Management, the surety shall be a company listed under "Surety Companies Acceptable on Federal Bonds." This list is published annually as of July 1 in the Federal Register.

Performance bonds shall be conditioned upon the compliance with the requirements of the State Land Department and the Bureau of Land Management and the requirements of the specifications for the clearing of pit sites, the removal of material and the cleaning up of pit sites.

Copies of fully executed performance bonds shall be mailed as follows:

State Land Commission	Bureau of Land Management
State Land Department	Manager, Land Office
1624 West Adams Street	2400 Valley Bank Center
Phoenix, Arizona 85007	Phoenix, Arizona 85073

1001-3.06 Sampling and Testing:

The results of any sampling and testing accomplished by the Department will be available from the Materials Group, 1221 N. 21st Avenue, Phoenix, Arizona 85009-3740.

1001-4 Contractor-Furnished Source:

1001-4.01 Approval Requirements:

(A) General:

The contractor shall promptly advise the Engineer as to the source that it proposes to use.

The contractor acknowledges that all the conditions set forth in this subsection must be met before the source may be used.

Other than sampling and testing, the requirements of this subsection shall be completed prior to initiation of any activities which disturb the existing conditions at the proposed source.

The contractor further acknowledges that no additional compensation will be made on account of any delays in preparing or modifying the environmental analysis, obtaining approval for the use of a contractor-furnished source, or the failure to obtain approval of a contractor-furnished source. An extension of contract time may be granted only in accordance with Subsections 104.12 or 1001-4.01(B)(4).

(B) General Requirements For Approval:

The use of a contractor-furnished source will require written approval by the Engineer. No approval will be given until the contractor has complied with the following conditions:

(1) The contractor has submitted an Environmental Analysis of the source proposed for use and the Department has reviewed the analysis and satisfied itself that the use of such source will not have an adverse social, economic or environmental impact. The requirements of this condition shall be completed

prior to initiation of any activities which substantially disturb the existing conditions at the proposed source.

(2) Except for commercial operations, the contractor has furnished the Engineer with evidence that he has secured the rights to the source, including ingress and egress.

(3) TheDepartment has determined that the material from the proposed contractor-furnished source not only meets the requirements, but is also compatible with the established project design criteria developed by the ADOT Materials Group and based on the soil support value of the embankment; and, except for commercial operations, the sampling and testing herein specified has been satisfactorily completed.

(4) For a contractor-furnished source which is not a commercial operation as defined in Subsection 1001-2.01, the contractor shall notify the Arizona Department of Agriculture, in accordance with the Arizona Native Plant Law, at least 30 days prior to any clearing operations of less than 40 acres on private land, 60 days prior to clearing operations of 40 or more acres on private land, and 60 days prior to any clearing of state land, regardless of size. If the Engineer is convinced that the contractor has made every effort to comply with the provisions of the Arizona Native Plant Law in contacting the Department of Agriculture, the Engineer will increase the number of contract days by the amount of time required for action by the Department of Agriculture. The increase will not exceed 20 contract days and will be concurrent with any increase allowed for the preparation of the Environmental Analysis.

(C) Historical and Cultural Resources:

If the Department determines that the proposed use will have major adverse impact on cultural or historic resources, the Department will not allow the use of the source.

1001-4.02 Testing Requirements:

The contractor shall furnish equipment and personnel and shall obtain representative samples of the material under the supervision of the Engineer. At the option of the contractor, the material shall be tested by either the Department or by a testing laboratory approved by the Department.

If testing is performed by a testing laboratory, the contractor shall arrange for the samples to be delivered to the testing laboratory. Tests shall be performed using appropriate test procedures referred to in the sections of the specifications in which the specific material requirements are described.

The contractor shall make the arrangements necessary to see that the testing laboratory submits the results of the tests to ADOT Materials Group. The contractor shall submit to ADOT Materials Group sufficient material from the samples taken so that ADOT Materials Group may test the materials and verify the results.

The cost of all sampling and testing, including the cost of supervision by the Engineer, shall be borne by the contractor until the testing has been satisfactorily completed.

Exploratory sampling and testing activities conducted prior to the Department's approval shall be limited to the minimum amount of vegetation removal and surface disturbance required to obtain representative samples. The contractor shall not produce material, mobilize crushing equipment or clear a worksite prior to approval of the Environmental Analysis.

The use of material from commercial operations will require written approval by the Engineer. No approval shall be assumed, nor will it be made, until the Department has determined that the material not only meets the specified requirements, but is also compatible with the established project design criteria developed by ADOT Materials Group, and based on the soil support value of the embankment materials and the structural coefficients of the base and surfacing materials.

Every effort will be made by the Department to advise the contractor as quickly as possible that the source it proposes to use has been either approved or disapproved. The contract time will not be adjusted because of any time required by either the contractor or the Department to sample and test the material and to determine the quality of the material.

1001-5 Blank

1001-6 Special Access:

If there is a Department-furnished source, the point(s) at which special access to a controlled access highway may be allowed will generally have been considered and, if appropriate, will be shown on the project plans. Such access shall be in accordance with the requirements specified in the Special Provisions and on the project plans.

The contractor may make a request to the Engineer to approve special access to a controlled access highway if:

(1) Special access is not shown on the project plans,

(2) The contractor elects not to furnish material from the Department-furnished source, or

(3) There is no Department-furnished source.

The request by the contractor shall be accompanied by an Environmental Analysis and by documents which specify the point(s) of access, the acquisition of right-of-way, the manner in which access will be attained, the traffic control plan, and crossovers, along with all other appropriate data which will allow the Engineer to evaluate its request. If the request is approved, a supplemental agreement shall be entered into.

All costs associated with the special access requested by the contractor shall be borne by the contractor, including, but not limited to, cattle guards, fences, gates and restoration work.

When access is not being utilized, gates shall be closed and locked. Upon completion of all operations, the area within the right-of-way which has been disturbed shall be restored to the condition existing prior to the contractor's operations.

The decision by the Engineer to deny a request by the contractor will be considered to be final.

1001-7 Operations at Source:

1001-7.01 General Requirements:

The requirements of Subsection 1001-7 shall not apply to commercial operations.

In Department-furnished sources the contractor shall conduct its operations in such a manner as to preserve available materials in excess of project requirements.

The contractor shall notify the Engineer in advance of operations at the source. Notice shall be given before and after clearing and stripping and before and after cleaning up.

1001-7.02 Clearing and Stripping:

Before beginning stripping, the contractor shall clear and grub the source as necessary to prevent the contamination of materials to be used in the work. Clearing and grubbing shall be in accordance with the requirements of Section 201, except that the resulting surface need not be leveled and vegetable matter need not be separated from any overburden which the Engineer determines to be unsuitable for any future use and which is to be wasted.

In the disposal of all tree trunks, stumps, brush, limbs, roots, vegetation and other debris removed, the contractor shall comply with the requirements of Title 36, Public Health and Safety, Chapter 6, Article 8, Air Pollution, of the Arizona Revised Statutes and with the Rules and Regulations for Air Pollution Control, Article 7, adopted by the Arizona Department of Environmental Quality pursuant to the authority granted by the Statutes.

Burning will be permitted only after the contractor has obtained a permit from the Arizona Department of Environmental Quality, and from any other Federal, State, County or City Agency that may be involved.

When stripping is required, overburden shall be removed to the extent necessary to remove all undesirable materials and shall, at all times, be kept stripped at least five feet beyond the working face of the area being excavated.

1001-7.03 Extraction of Materials:

Materials shall be removed from the source in a workmanlike manner. In order to produce acceptable material in the amount and gradation required, it may be necessary for the contractor to do any or all of the following, along with any other similar operations usually associated with the extraction, processing and production of the particular material being produced:

Move materials from one area to another.
Perform additional screening.
Remove, wash and waste material.
Blend materials.
Revise crushing methods.
Remove deleterious materials such as clay balls, roots and sticks.

If the Engineer determines that the material in a source is stratified, all material except borrow shall be removed for the full depth in such a manner as to produce a uniform blend of the material. Placing the material from different areas and depths into a surge pile and removing material from the surge pile by cutting through the pile will be acceptable provided that a uniformly blended material is obtained.

Material sources located in drainage channels such as washes, river beds, etc., may experience seasonal variations in the depth of ground water. In order to produce the quantity of material estimated to be available in Department-furnished sources, the contractor may be required to work below the water table.

1001-8 Fences and Cattle Guards:

Where the haul roads to material sources cross existing fence lines in areas where there is livestock of any kind, temporary cattle guards shall be installed by the contractor at each crossing.

The livestock operator or owner shall be contacted prior to the beginning of any operations and effective measures shall be taken and means provided by the contractor to prevent livestock from straying.

In operations where conditions will exist that are dangerous to livestock of any kind, temporary cattle guards and fence shall be installed around the pit area by the contractor to protect livestock.

Temporary cattle guards and fence installed by the contractor shall be removed and existing fence disturbed shall be replaced or reconstructed and all fence shall be left in as good condition as it was prior to the beginning of work.

1001-9 Cleaning Up:

The requirements of this subsection shall apply to contractor-furnished sources to the extent that they are required by the Environmental Analysis and by the owner. The requirements of Subsection 1001-9 shall not apply to commercial operations.

All overburden and other undesirable materials removed and all piles of waste materials resulting from operations in Department-furnished sources shall be deposited within the excavated area of the source and the material shall be leveled as directed. In the event that the Department-furnished source contains material needed for future use, the placement of such materials within the excavated area shall be as directed. All debris shall be removed and disposed of and, if directed, all open test holes shall be filled. The sides of Department-furnished sources shall be sloped and smoothed so that livestock can enter and leave the excavated area safely. Unless otherwise specified, all haul roads constructed to Department-furnished sources shall be obliterated and, as far as practicable, the ground left in as good condition as it was prior to hauling.

1001-10 Method of Measurement and Basis of Payment:

Except as may be otherwise specifically provided for in this section or elsewhere, no measurement or direct payment will be made for any costs involved in the procuring of materials. Such costs shall be considered as included in the cost of contract items.

SECTION 1002 PAINT:

1002-1 Requirements:

(A) General:

All paints furnished shall be ready-mixed at the manufacturer's plant, except for aluminum paint and zinc paint, which shall be mixed at the project site or fabricator just prior to application. All paints shall be standard paint products of the manufacturer with published product data sheets and shall comply in all details with the paint specifications as listed herein.

Ready-mixed paint shall be homogeneous, free of contaminants, and shall be of a consistency suitable for the use for which it is specified. The pigment shall be finely ground and properly dispersed in the vehicle, according to the requirements for the type of paint, and this dispersion shall be such that the pigment does not settle appreciably, does not cake or thicken in the paint container, and does not become granular, jelled or curdled. Any settlement of pigment in the paint shall be easily dispersed with a paddle so as to produce a smooth uniform paint of the proper consistency. The manufacturer shall include in the paint the necessary additives for control of sagging, leveling, drying, drier absorption and skinning.

Paint shall be furnished in new, unopened air-tight containers, which are clearly labeled with the exact title of the paint, Federal Specification number when applicable, name and address of the manufacturer, product code, date of paint manufacture, and the lot or batch number. The containers shall meet U.S. Department of Transportation Hazardous Materials Shipping Regulations. Precautions concerning the handling and the application of the paint shall be shown on the label of the paint containers.

When painting structural steel, the supplier or manufacturer of the primer, intermediate coat, and topcoat of paint shall be the same and the paint coats shall be compatible with each other, forming a complete paint system.

The contractor shall submit to the Engineer a Certificate of Compliance for each lot or batch of paint supplied, in accordance with Subsection 106.05, prior to its use. Product data sheets listing the paint constituents and their proportions as well as Materials Safety Data Sheets (MSDS) are required for each paint material supplied prior to its use.

All applicable governmental environmental regulations shall be adhered to during cleanup and for the disposal of unused paint.

(B) Three-Paint Coating System:

All three-paint coating systems, as specified in Subsection 1002-2.01, shall be ready-mixed at the manufacturer's plant.

Only approved paint systems will be allowed for use on structural steel. Paint systems approved in accordance with Subsection 1002-3(B) are shown on the Department's Approved Products List. Copies of the most current version of the Approved Products List are available on the internet at http://www.dot.state.az.us/ABOUT/atrc/apl.htm. Paint supplied by an approved manufacturer with a different product code from that which was previously evaluated and approved will require evaluation to determine if it is acceptable. It is the responsibility of the manufacturer to submit the necessary samples for paint system evaluation and approval. Approved paint systems will be removed from the list if it is determined through long-term performance testing or by their performance in the field that they are unacceptable.

(C) Aluminum and Zinc Paints:

Aluminum and zinc paints shall be mixed at the project site or fabricator just prior to application.

For safety purposes, aluminum paint shall be mixed only as needed and any unused paint shall be safely discarded and shall not be stored.

(D) Acrylic Emulsion Paint:

Paints approved in accordance with Subsection 1002-3(D) are shown on the Department's Approved Products List (APL). Copies of the most current version of the APL for paints are available on the internet at http://www.dot.state.az.us/ABOUT/atrc/apl.htm. For paints supplied which are not shown on the Approved Products List, a Certificate of Analysis showing conformance to Subsection 1002-2.04 for each lot or batch of paint supplied shall be submitted to the Engineer in accordance with Subsection 106.05, prior to its use.

1002-2 Paints:

Lead, lead compounds, soluble barium compounds, or hexavalent chromium compounds shall not be used as raw materials in the paint formulas specified under this section. Lead, lead compounds, soluble barium compounds or hexavalent chromium compounds shall not be added to any paint formulas specified under this section.

The use of halogenated solvents is not permitted.

Raw materials used in the paint formulas shall conform to the specifications designated by ASTM or by Federal or Military Specifications listed herein, except as otherwise specified herein. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products. No "or equal" substitutions for any specified material shall be made without the written consent of the Engineer.

A three-paint system shall be water-borne and each paint shall be ready-mixed by the manufacturer. The volatile organic content of the mixed paint shall not exceed 2.1 pounds per gallon.

Zinc paint shall be in accordance with Subsection 1002-2.02.

Aluminum paint shall be water-borne and shall be mixed in accordance with Subsection 1002-2.03.

All paints will be sampled and tested in accordance with Subsection 1002-3.

1002-2.01 Three-Paint Coating System:

(A) General:

A three-paint coating system shall include a primer (Paint Number 1), intermediate coat (Paint Number 2), and topcoat (Paint Number 3) from the same system. A three-paint coating system will be tested as a complete system in accordance with Subsection 1002-3(B).

Each individual paint shall conform to all of the chemical and physical characteristics and properties as declared on the manufacturer’s product data sheet. In addition, the paint color shall be as specified in the project plans, and the consistency shall be in accordance with the manufacturer’s recommendations. The contractor shall use the checking and calibration procedures found in ASTM D 4212 and verify the paint consistency with the Engineer prior to each application.

Each coating is intended for spray application. Limited application can be made by brushing or rolling if approved by the Engineer.

(B) Paint Number 1 - Primer:

This paint shall be used on blast cleaned steel surfaces for the first coat of a three-paint coating which must include Paint Number 2 and Paint Number 3 from the same system.

(C) Paint Number 2 - Intermediate Coat:

This paint for intermediate coats shall be used on primed steel surfaces as the second coat of a three-paint coating system which must include Paint Number 1 and Paint Number 3 from the same system. The paint shall be appropriately tinted to contrast with the prime coat.

(D) Paint Number 3 - Topcoat:

Paint for topcoats shall be used as the third coat of a three-paint coating system which must include Paint Number 1 and Paint Number 2 from the same system.

For topcoats, the gloss shall also be as specified on the project plans. The available colors for topcoats shall provide visual matches to the colors given in the Federal Standard No. 595. The colors shall be available in high-gloss enamels, if required.

When specified, a two-part aluminum paint conforming to Subsection 1002-2.03 shall be applied as the topcoat. The two parts shall be mixed in accordance with the manufacturer's label directions prior to use.

1002-2.02 Zinc Paint:

(A) General:

This paint shall be a zinc-dust, zinc-oxide primer conforming to the requirements of Federal Specification TT-P-641G, Type III, zinc dust, zinc oxide phenolic resin primer modified to conform to the requirements (1) through (8) below, and as otherwise specified herein.

The Volatile Organic Compound or solvent portion of the vehicle shall conform to the following requirements by volume:

(1) Solvents with an olefinic or cyclo-olefinic type of unsaturation shall not exceed five percent.

(2) The total of aromatic compounds with eight or more carbon atoms in the molecule, except ethylbenzene shall not exceed eight percent.

(3) The total of ethylbenzene, toluene, and branched-chain ketones shall not exceed 20 percent.

(4) A solvent which may be classified into more than one of the above groups shall be considered a member of the group having the lowest allowable concentration.

(5) The total of (1), (2), and (3) shall not exceed 20 percent.

(6) The volatile solvents shall contain no benzene or halogenated compounds.

(7) All paints shall be completely miscible with mineral spirits conforming to Grade II of Federal Specification TT-T-291.

(8) Mineral spirits, conforming to Grade II, of Federal Specification TT-T-291 shall be the preferred thinner for all paints specified in this Subsection. If necessary, other paint thinners conforming to the requirements of (1) through (6) above may be used.

If modified colors are required, pigments which do not contain lead, lead compounds, soluble barium compounds, or hexavalent chromium compounds shall be used in amounts not exceeding ten percent of the total pigment weight and replacing an equal weight of zinc oxide.

This specification covers a ready-to-mix or semi-prepared primer for use on, or repair of, galvanized metal surfaces. The primer ingredients shall be furnished in two separate containers, one consisting of a liquid (zinc oxide-vehicle) and the other of zinc dust which is to be added to the zinc oxide-vehicle just prior to use. When the entire amount of zinc dust from one container is mixed with all of the zinc oxide-vehicle from another container, a primer, conforming to all the requirements of this specification, shall result. The mixed primer shall normally be of a gray color characteristic of the composition, unless otherwise specified.

(B) Proportions:

One gallon of zinc dust, zinc oxide primer meeting this specification will have the following characteristics, when the minimum figures are met, and the pigment is a mixture of 80 percent zinc dust and 20 percent zinc oxide:

Constituent	Composition by Volume (gallons)	Composition by Weight (pounds)
Zinc dust	0.1445	8.50
Zinc Oxide	+ 0.0455	+ 2.12
Total Pigment	0.1900	10.62
Nonvolatile Vehicle	+ 0.3544	+ 2.99
Total Solids	0.5444	13.61
Volatile (thinner and Drier)	+ 0.4556	+ 2.99
Total primer (gallon)	1.0000	16.60

(C) Qualitative Requirements:

The mixed primer shall meet the following qualitative requirements:

Characteristics	Min.	Max.	Test Method
Pigment, percent by weight of primer	64	67	ASTM D 723
Water, percent by weight of primer	----	0.1	ASTM D 3960
Coarse particles and skins, percent by weight of pigment	----	4	ASTM D 185

Characteristics	Min.	Max.	Test Method
Consistency, Krebs-Stormer, shearing rate 200 r.p.m.	72	92	ASTM D 562
Time to set to touch, hours	0.5	4	ASTM D 1640
Time to dry, hours	----	18	ASTM D 1640
Weight per gallon, pounds	16.4	----	ASTM D 1475
VOC of mixed primer, lbs/gal.	----	3.5	ASTM D 3690

(D) Pigment:

The pigment composition in the mixed primer (except when colors other than gray are specified) shall be in accordance with the following:

Ingredients	Percent by Weight	
	Min.	Max.
Zinc Dust (ASTM D 520, Type I)	79	89
Zinc Oxide (ASTM D 79, American Process, Lead Free)	19	21

Upon analysis, the zinc dust shall show not less than 94 percent metallic zinc by weight. The pigment, extracted from the zinc oxide-vehicle and ignited, shall show on analysis not less than 98 percent zinc oxide by weight.

The total pigment (zinc dust plus zinc oxide) in the mixed primer shall contain a minimum of 74 percent metallic zinc and a minimum of 18 percent zinc oxide by weight. The sum of the percentage by weight of metallic zinc and zinc oxide in the total pigment of the mixed primer shall be not less than 97.

(E) Vehicle:

The vehicle shall consist of 100 percent phenolic resin spar varnish, suitable for grinding with zinc oxide, and shall have an oil-to-resin ratio of approximately 2 to 1 by weight.

The resin shall be 100 percent paraphenyl phenol-formaldehyde resin of the fortifying type, meeting the requirements of Federal Specification TT-R-271.

The vegetable oils shall consist of equal parts by volume of tung oil meeting the requirements of Federal Specification TT-T-775 and linseed oil conforming to Federal Specification TT-L-90.

The volatile solvent used shall be any solvent system complying with Subsection 1002-2.02(A) and applicable air pollution regulations by weight per gallon, Subsection 1002-2.02(C). Antiskinning agents may be present.

The vehicle shall contain not less than 50 percent solids by weight when tested according to Federal Standard No. 141, Method 4051.

1002-2.03 Aluminum Paint:

This paint is a two-part waterborne leafing aluminum paint formulated for use on properly prepared metal surfaces exposed to the air. Aluminum paint shall conform to California D.O.T. Specification Formula PWB-160 or as otherwise specified herein. This paint may be utilized for the finish coat when the aluminum color is specified on the plans. Aluminum paint must be compatible with the underlying paint coats. The quantity of aluminum paint mixed during any one day shall be limited to the quantity to be used during that day. The paint shall be mixed in accordance with the manufacturer's label directions prior to use.

For safety purposes, aluminum paint shall be mixed only as needed and any unused paint shall be safely discarded and shall not be stored.

(A) Composition:

This paint shall be supplied with 1.5 pounds of the specified aluminum paste to one gallon of vehicle.

(B) Pigment:

a) Ingredients:

Water dispersible Aluminum Paste (1)

b) Characteristics:

Non-volatile content, percent, ASTM D 480	72 minimum

(C) Vehicle:

a) Ingredients:			% by Weight
Acrylic Latex (2)			89.31
2,2,4-Trimethylpentanediol-1,3-monoisobutyrate			4.44
Ammonium Hydroxide (28%)			0.47
Defoamer (3)			0.35
Preservative (4)			0.05
Thickener (5)	}	Premix	approx. 0.12
2-(2-Methoxyethoxy) ethanol	}		5.26

b) Characteristics:	Requirements
Density, grams per milliliter, ASTM D-1475	1.01 to 1.03

Nonvolatile content, percent, ASTM D2369, B	36.5 - 38.5
Viscosity, centipoises, ASTM D2196,	
Test Method A (50 RPM, #3 spindle)	900 - 1200
High-shear viscosity, ASTM D-4287,	
0 to 5-P cone, shear rate 12 000 s^{-1}	0.5 to 0.7
pH	9.0 - 9.5

(1) Hydro Paste® 830 (Silberline)
(2) Maincote® HG-54D (Rohm and Haas)
(3) Foamaster® AP (Henkel)
(4) Proxel® GXL (ICI Americas)
(5) Acrysol® RM•8W (Rohm and Haas)

(D) Mixed Paint:

a) Characteristics:	Requirements
Nonvolatile Content, volume percent	
(calculated using maximum mix water)	33 - 35
Drying time, 100 µm wet film, ASTM D-1640	
set to touch, hours	½ maximum
dry through, hours	1 maximum

(E) Mixing Procedures:

Add 0.5 gallons of potable water to the aluminum paste and mix to a smooth, lump-free consistency. Slowly stir in the vehicle. Mix well, but avoid incorporating air into the paint. Strain the mixed paint through a double layer of cheesecloth prior to use. THE PAINT MUST BE MIXED FRESH EACH DAY. DO NOT STORE MIXED PAINT. DO NOT PLACE MIXED PAINT IN SEALED CONTAINERS.

(F) Application:

The mixed paint shall be applied to a total dry film thickness of at least 2.0 mils. This coating is intended for spray application; however, limited application can be made by brush. Paint should not be applied when the ambient or surface temperature is above 100 °F, or below 50 °F, or when the relative humidity exceeds 75 percent.

(G) Clean-up:

Use tap water for clean-up. Ten percent ammonia, acetone, or other suitable solvent may be used to remove dried paint from spray guns and other equipment. All applicable governmental pollution regulations shall be adhered to during cleanup and for the disposal of unused paint.

1002-2.04 Acrylic Emulsion Paint:

Acrylic emulsion paint shall be water-borne and conform to the requirements of Federal Specification TT-P-19 Paint, Acrylic Emulsion Exterior. Acrylic emulsion paint will be tested in accordance with Subsection 1002-3(D).

This paint may be tinted by using “Universal” or “all purpose” concentrates.

The color of the final coat of paint shall be as indicated on the project plans. If no color is specified on the plans, the paint color shall approximate that of paint color chip No. 30318, as specified by Federal Test Standard Number 595, when applied to either a concrete test specimen measuring two-foot by two-foot, or to the surface of the concrete structure to be painted.

The Engineer will determine color acceptance by visual inspection.

1002-3 Sampling and Testing:

(A) General:

Any lot or batch of paint may, at any time, be sampled at random and tested for conformance to any of the chemical and physical characteristics and properties as declared by the manufacturer on the respective product data sheet. Also, complete three-paint coating system samples may be required at any time for follow-up evaluation using the performance test method employed in the original evaluation for approval of the system.

(B) Three-Paint Coating System:

Paint coatings in Subsection 1002-2.01 will be tested as a complete three-paint coating system. Paint systems shall have an evaluation rating of 100 or greater, as described below, after being weathered in accordance with the requirements of ASTM D 4587 and ASTM G 53 in the Q-U-V Accelerated Weathering Tester (Fluorescent UV/Condensation Apparatus). Paint systems will be tested as follows:

1. Paint coatings will be applied to cold rolled steel panels (ASTM D 609, Type 3, ASTM A 366). The paint will be thinned to 75 ± 2 Ku consistency using demineralized water. Three coats, each approximately 2 mils thickness are applied to each of four panels according to ASTM D 823. The fourth coated panel from each set will be inscribed with an “X” cut to the steel substrate and extending across the entire coated area.

2. The exposure cycle used with the weathering tester shall be D = 8 h UV/60 degree C followed by 4 h CON/45 degree C. One panel from each set of four shall be removed at 500 hours and another at 750 hours. The last two panels shall be removed at 1000 hours.

3. Paint systems will be evaluated on the basis of six measures of degradation which may be found to occur under the conditions of exposure. For each measure, a rating scale of from one to five points will be applied. A rating of one point indicates the poorest performance and five points indicate the best

performance. The rating from each measure is multiplied by a weighting factor which represents the relative importance of that measure. The product is a score for that measure. The sum of the scores for all measures is the overall score for the system. All paint systems shall have an overall score of 100 or higher.

A) Cracking/Flaking: Three ASTM standard test methods are used to provide a measure of the degree of degradation in this area: ASTM D 660, ASTM D 661, and ASTM D 772. The definitions and illustrations contained in these methods are used in combination for the rating scale. A weighting factor of three will be applied to the results of these tests.

B) Blistering/Flaking: Two ASTM methods are combined for this rating scale: ASTM D 714 and ASTM D 772. A weighting factor of three will be applied to the results of these tests.

C) Corrosion: A rating scale is derived from ASTM D 610 for evaluating the degree of rusting. A weighting factor of three will be applied to the results of this test.

D) Chalking/Erosion: Two ASTM methods are combined for this rating scale: ASTM D 4214 and ASTM D 662. A weighting factor of three will be applied to the results of these tests.

E) Adhesion: The tape test is based on ASTM D 3359 and the rating scale is from the Classification of Adhesion Test Results under Test Method B. A weighting factor of five will be applied to the results of this test.

F) Flexibility: This is a modified version of ASTM D 522 using a 1-1/4 inch mandrel. The degree of cracking observed after bending is used for the rating. A weighting factor of five will be applied to the results of this test.

Paint may also be tested in accordance with the requirements of Arizona Department of Transportation Testing procedures, ASTM, and Federal Test Method Standard Number 141.

(C) Aluminum and Zinc Paint:

Aluminum and zinc paint vehicles may be tested in accordance with the requirements of ASTM D 2621, ASTM D 2805, ASTM E 1347, and Federal Test Method No. 141.

(D) Acrylic Emulsion Paint:

Acrylic emulsion paints will be tested in accordance with the following procedure:

1) Resistance To Accelerated Weathering**:**

The paint will be applied to concrete mortar panels and weathered in a Q-U-V accelerated weathering tester, according to ASTM G 53, for 300 hours utilizing UVB-313 lamps and the exposure cycle as specified in Subsection 4.3.5.2 of Federal Specification TT-P-19. The paint weathered in this manner shall show no appreciable change in color or appearance due to fading, chalking, or material reaction.

2) TT-P-19 Requirements**:**

All performance requirements listed in Section 3 of Federal Specification TT-P-19 will be met as specified when tested according to the applicable test methods as specified in Section 4 of Federal Specification TT-P-19.

3) Adhesion**:**

The acrylic emulsion paint will be applied to a concrete test specimen or to the final concrete surface and subjected to one or both of the methods of adhesion testing described below, after a minimum period of 7 days of sunlight after application.

Adhesion will be measured in accordance with the requirements of ASTM D 3359. When Test Method A is used, a rating of 3A will be required. When Test Method B is used, a rating of 2B will be required.

4) Testing:

Random inspection testing of the completed paint finish will be performed by the Engineer according to the above performance requirements. Non-compliance with these test results will require remedial action which may include substitution of the paint supplied, modification to the application plan, removal and repainting of the non-compliance section(s), or other action as deemed appropriate by the Engineer.

SECTION 1003 REINFORCING STEEL:

1003-1 General Requirements:

Reinforcing steel shall be furnished in the sizes, shapes, and lengths shown on the plans and in conformance with the requirements of this Section. Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

When reinforcing steel is delivered to the site of the work, the contractor shall furnish the Engineer with three copies of all shipping documents. Each shipping document shall show the sizes, lengths and weights of the reinforcing steel separately for each structure.

1003-2 Reinforcing Bars:

Except when used for wire ties or spirals, steel bars used as reinforcement in concrete shall be deformed and shall conform to the requirements of AASHTO M 31 (ASTM A 615).

Where shown on the plans, the bars shall be Grade 60.

Where Grade 60 is not specified on the plans, Grade 40 shall be used if immediately available. If Grade 40 is not immediately available, Grade 60 may be used exclusively or in combination with Grade 40 provided that the conditions under which the grades are used in combination are acceptable to the Engineer and further provided that there is no additional cost to the Department.

1003-3 Wire:

Steel wire used as spirals or ties for reinforcement in concrete shall conform to the requirements of AASHTO M 32.

1003-4 Welded Wire Fabric:

Welded wire fabric used as reinforcement in concrete and mortar shall conform to the requirements of AASHTO M 55.

1003-5 Epoxy Coated Reinforcing Bars:

1003-5.01 Steel:

Steel reinforcing bars shall conform to the requirements of Subsection 1003-2.

1003-5.02 Epoxy for Coating:

A list of powdered epoxy resins which have passed prequalification tests, as described in AASHTO M 284 "Epoxy Coated Reinforcing Bars," and which may be used if the material is applied and cured in the same manner as that used to coat the test bars in the original powder prequalification test may be found on the Department's Approved Products List. Copies of the most current version are available on the internet at http://www.dot.state.az.us/ABOUT/atrc/apl.htm.

Prequalification testing may be performed by the National Bureau of Standards, State laboratories, or qualified private independent laboratories.

The powdered epoxy resin selected by the contractor and furnished by the manufacturer shall be of the same material and quality as the resins listed on the Approved Products List.

The approved powders are based on specific reinforcing steel preparation and powder application and curing methods and these identical methods shall be followed during fabrication.

The coating manufacturer shall supply the purchaser with a certification which properly identifies the batch and/or lot number, material, quantity of batch, date of manufacture, name and address of manufacturer and a statement that the material is the same composition as the initial sample prequalified for use. A statement shall also be submitted

regarding the fact that production bars and prequalification bars have been identically prepared and applied with epoxy powders.

Patching or repair material, compatible with the coating and inert in concrete, shall be made available by the epoxy coating manufacturer. This material shall be suitable for repairs made by the contractor of areas of the coating damaged during fabrication and/or handling in the field.

1003-5.03 Application of Coating:

The coating applicators facilities shall be subject to approval by the Department. Applications for approval of facilities shall be made to the Department by the coating applicator.

The surface to be coated shall be blast cleaned in accordance with the requirements of the Steel Structures Painting Council-Surface Preparation Specification No. 10 (SSPC-SP10), Near White Blast Cleaning.

The powdered epoxy resin coating shall be applied to the cleaned surface as soon as possible after cleaning and before visible oxidation occurs. In no case shall more than eight hours elapse between cleaning and coating.

The protective epoxy coatings shall be applied by the electrostatic spray method or the electrostatic fluidized bed method in accordance with the recommendations of the coating manufacturer. The epoxy coating may be applied before or after fabrication of the reinforcing.

The epoxy coating shall be applied as a smooth uniform coat. After curing, the coating thickness shall be seven ± two mils. Coating thickness shall be controlled by taking measurements on a representative number of bars from each production lot. Coating thickness measurements shall be conducted by the method outlined in ASTM G 12.

The coating shall be checked visually after cure for continuity. It shall be free from holes, voids, contamination, cracks and damaged areas.

The coating shall not have more than two holidays (pinholes not visible to the naked eye) in any linear foot of the coated item. A holiday detector shall be used, in accordance with the manufacturer's instructions, to check the coating for holidays.

The flexibility of the coating shall be evaluated on a representative number of bars selected from each production lot. The coated bar shall be bent 120 degrees (after rebound) around a six-inch diameter mandrel. The bend shall be done at a uniform rate and may take up to one minute to complete. The test specimens shall be at thermal equilibrium between 68 and 85 degrees F at the time of testing. No cracking of the coating shall be visible to the naked eye on the outside radius of the bent bar.

The contractor shall furnish a Certificate of Compliance from the coating applicator, in accordance with the requirements of Subsection 106.05 with each shipment of coated steel.

The Certificate of Compliance shall (1) verify that the coated items and coating material have been tested in accordance with the requirements of these specifications, (2) state the actual test results for each requirement, (3) state that the test results comply with the requirements, and (4) state that the entire lot is in a fully-cured condition.

The coating applicator shall be responsible for performing quality control and tests. This will include inspection for compliance with the requirements of coating thickness, continuity of coating and coating cure and the testing required under Flexibility of Coating, in accordance with the requirements of this subsection.

The Department reserves the right to have its authorized representative observe the preparation, coating and testing of the reinforcement bars. The representative shall have free access to the plant, and any work done when access has been denied will be automatically rejected.

If the representative elects, lengths of coated bars may be taken from the production run on a random basis, for test, evaluation and check purposes by the Department.

1003-5.04 Shop Repair:

Epoxy coated reinforcement bars which do not meet the requirements for coating thickness, continuity of coating, coating cure or flexibility of coating shall not be repaired.

Reinforcement bars with these defects shall be replaced or alternately, stripped of epoxy coating, recleaned and recoated in accordance with the requirements of this specification.

Coating breaks due to fabrication and handling shall be repaired with patching material if the defective area exceeds two percent of the surface area of the bar in a one-foot length and the damaged spot is larger than 1/4 by 1/4 inch.

The repair of coating breaks shall be limited to bars on which the total of the defective coating areas does not exceed five percent of the surface area of the reinforcement bar. Bars with greater than five percent damage shall be replaced or alternately, stripped of epoxy coating, recleaned and recoated in accordance with the requirements of this specification.

SECTION 1004 STRUCTURAL METALS:

1004-1 General Requirements:

Certificates of Analysis conforming to the requirements of Subsection 106.05 shall be submitted.

1004-2 Structural Steel:

Structural carbon steel shall conform to the requirements of AASHTO M 183 (ASTM A 36).

High strength low-alloy structural columbium vanadium steel shall conform to the requirements of AASHTO M 223.

High strength low-alloy structural steel up to four inches thick with 50,000 pounds per square inch minimum-yield point shall conform to the requirements of AASHTO M 222 (ASTM A 588).

1004-3 Steel Structural Rivets:

Steel structural rivets shall conform to the requirements of AASHTO M 228 (ASTM A 502).

1004-4 Bolts, Nuts and Washers:

High strength structural steel, bolts and washers shall conform to the requirements of Section 604-2.03.

Bolts and nuts other than high strength steel bolts shall conform to the requirements of ASTM A 307, Grade A.

Nonheaded anchor bolts, either straight or swaged, to be used for structural anchorage, shall conform to the requirements of AASHTO M 183 (ASTM A 36).

1004-5 Steel Forgings:

Carbon steel forgings shall conform to the requirements of AASHTO M 102 (ASTM A 668, Class C).

1004-6 Castings:

Carbon steel castings shall conform to the requirements of AASHTO M 103 (ASTM A 27, Grade 65-35). Gray iron castings shall conform to the requirements of AASHTO M 105 (ASTM A 48, Class 30B). Malleable iron castings shall conform to the requirements of ASTM A 47, Grade 35018.

Drainage structure castings shall conform to the requirements of AASHTO M 306. The weight of aluminum covers shall not be less that 150 pounds.

1004-7 Cast Bronze and Copper-Alloy Plates:

Cast bronze bearing and expansion plates shall conform to the requirements of AASHTO M 107 (ASTM B 22, Copper Alloy UNS No. C 91100). Rolled copper-alloy bearing and expansion plates shall conform to the requirements of AASHTO M 108 (ASTM B 100, Copper Alloy UNS No. C 51000 and No. C 51100).

1004-8 Steel Tubes:

Steel tubes, low-carbon, tapered for structural use shall conform to the requirements of ASTM A 595, Grade A.

1004-9 Steel Pipe:

Steel pipe shall conform to the requirements of ASTM A 53, Grade B, Type E or S, except hydrostatic testing will not be required.

SECTION 1005 BITUMINOUS MATERIALS FOR SURFACING:

1005-1 General Requirements:

Bituminous materials shall conform, when tested in accordance with the tests hereinafter enumerated, to the following requirements, as applicable, for the types and grades designated and used.

Certificate of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1005-2 Sampling of Bituminous Material:

Sampling of bituminous material shall conform to the requirements of AASHTO T 40. Samples shall be taken by the contractor and witnessed by the Engineer. The point of sampling and the number of samples will be specified by the Engineer.

The contractor shall provide convenient facilities for obtaining accurate samples of bituminous material.

1005-3 Bituminous Material Requirements:

1005-3.01 Asphalt Cement:

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of AASHTO Provisional Standard MP1. The pressure aging temperature shall be as specified in the Special Provisions.

A minimum of seven working days prior to the start of asphaltic concrete production, the contractor shall provide the Engineer a one-gallon sample of the proposed asphalt binder and Certificate of Analysis showing complete AASHTO Provisional Standard MP1 asphalt binder testing. Laboratory-prepared samples will not be acceptable. Asphaltic concrete production shall not begin until the Engineer determines the acceptability of the proposed asphalt binder.

If, during asphaltic concrete production, it is determined by testing that asphalt cement fails to meet the requirements of AASHTO Provisional Standard MP1 for the specified grade, the asphaltic concrete represented by the corresponding test results shall be evaluated for acceptance. Should the asphaltic concrete be allowed to remain in place, the contract unit price will be adjusted by the percentage shown in Table 1005-1. Should the asphalt cement be in reject status, the contractor may supply an engineering analysis of the expected

performance of the asphaltic concrete in which the asphalt cement is incorporated. The engineering analysis shall detail any proposed corrective action and the anticipated effect of such corrective action on the performance. Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is rejected, the asphaltic concrete shall be removed and replaced with asphaltic concrete meeting the requirements of the applicable specifications at no additional expense to the Department. If the contractor's proposal is accepted, the asphalt concrete shall remain in place at the applicable percent of contract unit price allowed, and any necessary corrective action shall be performed at no additional cost to the Department.

1005-3.02 Liquid Asphalt:

Liquid asphalt shall conform to the requirements of AASHTO M 82, Cut-back Asphalt (Medium Curing Type).

Adjustments in the contract unit price, in accordance with the requirements of Table 1005-2, will be made for quantities of material represented by the corresponding test results.

1005-3.03 Emulsified Asphalt:

Emulsified asphalt shall conform to the requirements of Table 1005-3 for Anionic Rapid Set (RS-1, RS-2), Anionic Slow Set (SS-1), Cationic Rapid Set (CRS-1, CRS-2) and Cationic Slow Set (CSS-1).

Emulsified asphalts shall be homogeneous. If emulsified asphalt has separated, it shall be thoroughly mixed to insure homogeneity. If emulsified asphalt has separated due to freezing, it shall not be used. Emulsified asphalt shall not be used after 30 days from delivery.

1005-3.04 Emulsified Asphalt (Special Type):

Emulsified asphalt (special type) shall consist of Type SS-1 or CSS-1 diluted with water to provide an asphalt content not less than 26 percent. The material may be diluted in the field.

1005-3.05 Recycling Agents:

Recycling agents shall conform to the requirements of Table 1005-4.

1005-3.06 Emulsified Recycling Agents:

Emulsified recycling agents shall conform to the requirements of Table 1005-5.

1005-3.07 Other Requirements:

Other requirements for bituminous materials shall conform to the requirements of Table 1005-6.

TABLE 1005-1
ASPHALT BINDER PAY ADJUSTMENT TABLE

Test Property	Test Value	Percent of Contract Unit Price Allowed
Dynamic Shear of Original Binder: G*/Sin δ, kPa	0.90 - 0.99 0.70 - 0.89 Less than 0.70	95 85 70 †
Dynamic Shear of RTFO Binder: G*/Sin δ, kPa	2.00 - 2.19 1.60 - 1.99 Less than 1.60	95 85 70 †
Dynamic Shear of PAV Binder: G*Sin δ, kPa	5001 - 5500 5501 - 7000 7001 - 8000 More than 8000	95 85 75 65 †
Creep Stiffness of PAV Binder: S, Mpa	301 - 330 331 - 450 451 - 600 More than 600	95 85 75 65 †
m-value at 60 sec.	0.270 - 0.299 0.230 - 0.269 Less than 0.230	95 80 65 †

† Reject Status: The price adjustment applies if the asphaltic concrete is allowed to remain in place.

Notes:

Specified properties in AASHTO Provisional Standard MP1 for flash point, viscosity at 135 °C, and mass loss are not considered performance related. Specification deficiencies for these properties shall be cause for a work stoppage until specification properties are met, but will not be cause for a pay adjustment.

Should the bituminous material be deficient on more than one property, the price adjustment will be the greatest adjustment possible considering individual test results.

The information presented in this table does not apply to asphalt cement used for tack coats.

TABLE 1005-2
MC LIQUID ASPHALT

Grade	Viscosity: Centistokes, Deviations	Percent of Contract Unit Price Allowed

TABLE 1005-2 MC LIQUID ASPHALT		
70	70 - 140 63 - 69 or 141 - 154 52 - 62 or 155 - 175 Less than 52 or greater than 175	100 90 75 60 (1)
250	250 - 500 225 - 249 or 501 - 550 187 - 224 or 551 - 625 Less than 187 or greater than 625	100 90 75 60 (1)
800	800 - 1600 720 - 799 or 1601 - 1760 600 - 719 or 1761 - 2000 Less than 600 or greater than 2000	100 90 75 60 (1)
3000	3000 - 6000 2700 - 2999 or 6001 - 6600 2250 - 2699 or 6601 - 7500 Less than 2250 or greater than 7500	100 90 75 60 (1)

(1) If allowed to remain in place.

Note: Since volatile solvents utilized in the manufacture of MC Liquid Asphalt may volatilize in varying amounts during normal transporting, handling, and storage operations, whenever such Liquid Asphalts are used for prime coats or curing seals, deviations from the maximum specification limits greater than those listed may be permitted when justified. In such cases, when material is allowed to remain in place, 60% of the contract unit price is allowed.

TABLE 1005-3
EMULSIFIED ASPHALTS

Test On Emulsions	Test Method (1)	Requirement					
		RS-1	CRS-1	RS-2	CRS-2	SS-1	CSS-1
Viscosity: Saybolt Furol, seconds, range 77 °F 122 °F	T 59	20-100	20-100	50-400	50-400	20-100	20-100
Settlement: 5 days, %, maximum	T 59	5	5	5	5	5	5
Sieve: Retained on No. 20, %, maximum	T 59(2)	0.10	0.10	0.10		0.10	0.10

TABLE 1005-3
EMULSIFIED ASPHALTS

Particle Charge	T 59		Pos.		Pos.		Pos. (3)
Demulsiability: 35 mL, 0.02 N calcium chloride %, minimum	T 59	60		60			
Classification: Uncoated particles, %, minimum	Ariz. 502				55		
Residue: (4) Residue, %, minimum (5)		55	60	63	65	57	57

Notes:

(1) T 59 is AASHTO

(2) Distilled water will be used instead of the two percent sodium oleate solution.

(3) If the Particle Charge Test result is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

(4) Residue will be obtained in accordance with the requirements of Arizona Test Method 504 and shall conform to all the requirements of AASHTO Provisional Standard MP1 for PG 64-16, except that for CRS-2 the dynamic shear ($G^*/\sin\delta$) on the original residue shall be a minimum of 1.00 kPa and a maximum of 1.50 kPa.

(5) Residue by evaporation may be determined in accordance with the requirements of Arizona Test Method 512; however, in case of dispute, AASHTO T 59 will be used.

TABLE 1005-4
RECYCLING AGENTS

Test On Recycling Agent	Test Method	Requirement							
		RA-1		RA-5		RA-25		RA-75	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity: 140 °F, centistokes	T 201 (1)	100	200	200	800	1000	4000	5000	10000
Flash Point: Cleveland Open Cup,	T 48	340		375		425		450	

TABLE 1005-4
RECYCLING AGENTS

°F, minimum	(1)								
Saturate by weight: %	D 2007		30		30		30		30
Asphaltenes: % (2)	D 2006 -70		1.0		5.0		10.0		17.0
Chemical Composition: N+A1 (3) P+A2	D 2006 -70	0.2	1.0	0.2	1.2	0.2	1.4	0.2	1.6
Compatibility N (3) P	D 2006 -70	0.5		0.5		0.5		0.5	
Test on Residue: (4) Weight Change, %			6.5		4		3		2
Viscosity Ratio: (5)			3		3		3		3

Notes:

(1) Are AASHTO; Others are ASTM

(2) Asphaltenes for RA-1 may be determined in accordance with the requirements of Arizona Test Method 505; however, in case of dispute, ASTM D 2006-70 shall be used.

(3) N = nitrogen bases; P = paraffins; A1 = first acidaffins; A2 = second acidaffins.

(4) Residue will be obtained in accordance with the requirements of AASHTO T 240.

(5) Viscosity Ratio:

$$\frac{\text{Viscosity of residue at 140 °F, centistokes}}{\text{Viscosity of recycling agent at 140 °F, centistokes}}$$

TABLE 1005-5
EMULSIFIED RECYCLING AGENTS

Test on Emulsified Recycling Agent	AASHTO Test Method Except as	Requirement

TABLE 1005-5
EMULSIFIED RECYCLING AGENTS

	Shown	ERA-1	ERA-5	ERA-25	ERA-75
Viscosity: Saybolt Furol, 77 °F, seconds range	T 59	15 - 40	15 - 100	15 - 100	15 - 100
Miscibility	T 59	Passes	Passes	Passes	Passes
Sieve Test: %, maximum	T 59 (1)	0.10	0.10	0.10	0.10
Particle Charge	T 59	Positive	Positive	Positive	Positive
Residue: (2) Residue, %, minimum (3)		60	60	60	60

Notes:

(1) Distilled water will be used instead of the two percent sodium oleate solution.

(2) Residue will be obtained in accordance with the requirements of Arizona Test Method 504 and shall conform to all requirements specified in Table 1005-4.

(3) Residue by evaporation may be determined in accordance with the requirements of Arizona Test Method 512; however, in case of dispute, AASHTO T 59 will be used.

TABLE 1005-6
OTHER REQUIREMENTS

Grade of Asphalt Specification Designation	Range of Temperatures for Application by Spraying, °F	Range of and Max. Temperature of Aggregate for Plant Mixing, °F	Basis of Conversion Average Gallons Per Ton at 60 °F
Paving Asphalt	275 - 400	------	
PG 76-XX			232
PG 70-XX			233
PG 64-XX			235
PG 58-XX			236
PG 52-XX			238
Liquid Asphalt			
MC-70	105 - 175	90 - 155	253
MC-250	140 - 225	125 - 200	249

TABLE 1005-6 OTHER REQUIREMENTS			
MC-800 MC-3000	175 - 225 215 - 290	160 - 225 200 - 260	245 241
Emulsified Asphalt RS-1 CRS-1 RS-2 CRS-2 SS-1 CSS-1	 70 - 140 125 - 185 125 - 185 125 - 185 70 - 160 70 - 160	-----	240
Emulsified Asphalt (Special Type)	70 - 160	-----	240
Recycling Agent (RA-1, RA-5, RA-25, RA-75)	-----	-----	240
Emulsified Recycling Agent (ERA-1, ERA-5, ERA-25, ERA-75)	70 - 160	-----	240

SECTION 1006 PORTLAND CEMENT CONCRETE:

1006-1 General Requirements:

Portland cement concrete shall consist of a mixture of hydraulic cement, fine aggregate, coarse aggregate, water and admixtures.

The contractor shall determine the mix proportions and shall furnish concrete which conforms to the requirements of these specifications. All concrete shall be sufficiently workable, at the slump proposed by the contractor within the specified range, to allow proper placement of the concrete without harmful segregation, bleeding, or incomplete consolidation. It shall be the responsibility of the contractor to proportion, mix, place, finish, and cure the concrete properly in accordance with the requirements of these specifications.

1006-2 Materials:

1006-2.01 Hydraulic Cement:

Hydraulic cement shall consist of either Portland cement or Portland-pozzolan cement.

Portland cement shall conform to the requirements of ASTM C 150 for Type II or III.

Portland-pozzolan cement shall conform to the requirements of ASTM C 595 for Type IP (MS).

Hydraulic cement shall not contain more than 0.60 percent total alkali. The word alkali as used in these specifications shall be taken as the sum of sodium oxide and potassium oxide calculated as sodium oxide.

Certificates of Analysis conforming to the requirements of Subsection 106.05 shall be submitted.

Cement of different types or brands shall not be intermingled or used in the same batch. The contractor shall provide suitable means for storing and protecting the cement against dampness. Cement which for any reason has become partially set or which contains caked lumps shall not be used.

The use of either sacked cement or bulk cement is permissible. The use of fractional bags of sacked cement will not be permitted unless the contractor elects to weigh the cement into each batch.

1006-2.02 Water:

The water used shall be free from injurious amounts of oil, acid, alkali, clay, vegetable matter, silt or other harmful matter. Water shall contain not more than 1,000 parts per million of chlorides as Cl or of sulphates as SO_4.

Water shall be sampled and tested in accordance with the requirements of AASHTO T 26. Potable water obtained from public utility distribution lines will be acceptable.

1006-2.03 Aggregates:

(A) General Requirements:

When concrete is to be placed at elevations above 4,500 feet, the fine and coarse aggregate shall be subject to five cycles of the sodium sulfate soundness test in accordance with the requirements of AASHTO T 104. The total loss shall not exceed 10 percent by weight of the aggregate as a result of the test. Tests for soundness may be waived when aggregates from the same source have been approved and the approved test results apply to the current production from that source.

Mill tailings or material from mine dumps shall not be used in the production of fine or coarse aggregate.

The handling and storage of concrete aggregate shall be such as to minimize segregation or the intermixing and contamination with foreign materials. The Engineer may require that aggregates be stored separately. Different sizes of aggregate shall be separated by bulkheads or stored in separate stockpiles sufficiently removed from each other to prevent the material from becoming intermixed.

When aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and level. The bottom one-foot layer of aggregate shall not be disturbed or used.

The handling and storage of concrete aggregate for Class P concrete at the job site shall be such as to minimize segregation. Stockpiles shall be neat and regular in form and shall occupy as small an area as possible. Stockpiles shall be constructed by first distributing the aggregate over the entire base and then building upward in successive layers not more than five feet in depth. Aggregate shall not be dumped or spilled over the side of the pile. When a conveyor is used to stockpile aggregate, it shall be equipped with an adequate rock tremie or rock ladder to reduce segregation and it shall be moved continuously across the stockpile. The distance the material drops from the tremie shall not exceed 10 feet. Aggregate shall be distributed over the stockpile so that the formation of conical piles higher than 10 feet is prevented.

Contamination of concrete aggregate for Class P concrete by contact with the ground at the job site shall be positively prevented. The contractor shall take the necessary measures to prevent such contamination. Such preventive measures shall include, but not necessarily be limited to, placing aggregate on hardened surfaces consisting of Portland cement concrete, asphaltic concrete, or cement treated material.

The contractor shall maintain at least two full days worth of production of fine and coarse aggregate stockpiled at the batch plant for Class P concrete prior to starting and throughout the duration of Portland cement concrete paving operations. This requirement is waived for the last two days of production.

The following test methods will be used to evaluate the quality of aggregates for concrete:

Sampling	Arizona Test Method 105 & AASHTO T 2
Reducing field samples to testing size	AASHTO T 248
Clay lumps and friable particles	AASHTO T 112
Coal, lignite and lightweight particles	AASHTO T 113
Amount of material passing No. 200 sieve	Arizona Test Method 201
Organic impurities	AASHTO T 21
Sieving aggregates	Arizona Test Method 201
Soundness (Sodium Sulfate)	AASHTO T 104
Mortar-making properties	AASHTO T 71
Sand equivalent	AASHTO T 176
L.A. abrasion	AASHTO T 96
Fractured Coarse Aggregate Particles	Arizona Test Method 212

(B) Fine Aggregate:

Fine aggregate shall be a natural sand or other approved inert material with similar characteristics composed of clean, hard, strong, durable, uncoated particles. Fine aggregate shall be washed and shall conform to the requirements of AASHTO M 6, with the following exceptions:

The amount of deleterious substances in washed fine aggregate shall not exceed the following limits by dry weight:

Clay lumps	AASHTO T 112	0.50 %
Coal and lignite	AASHTO T 113	0.25 %
Shale and other materials having a specific gravity less than 1.95	Arizona Test Method 211	1.00 %

The maximum amount of all deleterious substances listed above shall not exceed 1.25 percent by dry weight.

The grading shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method 201.

Sieve Size	Percent Passing
3/8 in.	100
No. 4	95 - 100
No. 16	45 - 80
No. 50	0 - 30
No. 100	0 - 10
No. 200	0 - 4.0

Fine aggregate shall have an average sand equivalent value of not less than 75.

Fine aggregates shall be subjected to testing under AASHTO T 21 for organic impurities. Aggregates producing a color darker than the standard shall be rejected unless the material passes the mortar strength specified in the following paragraph:

Fine aggregate shall be of such quality that, when made into mortar and subjected to the test for mortar-making properties, the mortar shall develop a compressive strength at seven and 28 days of not less than 90 percent of that developed by a mortar prepared in the same manner with the same Type II cement and graded Ottawa sand having a fineness modulus of 2.40 ± 0.10.

(C) Coarse Aggregate:

Coarse aggregate shall consist of crushed stone, gravel, or other approved inert material of similar characteristics, including cinders when specified, having hard, strong and durable pieces free of clay and other deleterious substances. The aggregate shall be washed. The coarse aggregate graduation shall conform to the appropriate size designation of AASHTO M 43, except as shown below, when tested in accordance with the requirements of Arizona Test Method 201.

The amount of deleterious substances in washed coarse aggregate shall not exceed the following limits by dry weight, when tested with the following test methods, except as noted:

Clay lumps	AASHTO T 112	0.25 %
Coal and lignite	AASHTO T 113	0.25 %
Material passing No. 200 sieve	Arizona Test Method 201	0.5 % *
Shale and other materials having a specific gravity less than 1.95.	Arizona Test Method 211	1.00 %
* When coarse aggregate is 100 percent crushed aggregate, the maximum requirement for material passing No. 200 sieve shall be 1.0 percent by weight.		

The maximum amount of all deleterious substances listed above shall not exceed 1.25 percent by dry weight.

The percent of wear of coarse aggregate at 500 revolutions, when tested in accordance with the requirements of AASHTO T 96, shall not exceed 40.

1006-2.04 Admixtures:

(A) General Requirements:

The contractor shall furnish Certificates of Compliance conforming to the requirements of Subsection 106.05 for each type of admixture furnished. Admixtures containing chlorides are not acceptable.

All concrete admixtures shall be stored in suitable containers in accordance with the manufacturer's recommendations. All liquid admixtures shall be protected from freezing. Liquid admixtures that have frozen shall not be used.

(B) Air-Entraining Admixtures:

Air-entraining admixtures shall conform to the requirements of AASHTO M 154.

(C) Chemical Admixtures:

Chemical admixtures shall conform to the requirements of AASHTO M 194.

(D) Fly Ash:

Fly ash shall conform to the requirements of ASTM C 618 for Class C or F mineral admixture, except that the loss on ignition shall not exceed 3.0 percent.

Fly ash, when used as a replacement for Portland cement, shall have an R factor less than 2.5. The R factor is defined as (C-5 %)/F, where C is the calcium oxide content expressed as a percentage and F is the ferric oxide content expressed as a percentage. Fly ash shall not contain more than 1.5 percent available alkali as defined in ASTM C 311.

1006-2.05 Concrete Curing Materials:

Liquid membrane forming compound shall conform to the requirements of AASHTO M 148. Type 2 compound with either a Class A or Class B vehicle shall be used for concrete pavement, bridge decks, and approach slabs. Type 1-D compound with either a Class A or Class B vehicle shall be used for other concrete items.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1006-3 Design of Mixtures:

1006-3.01 Design Criteria:

Portland cement concrete shall conform to the requirements specified in Table 1006-A for each of the classes listed therein.

Unless otherwise shown in Table 1006-A, the proposed slump shall be chosen by the contractor. Concrete at the proposed slumps shall be sufficiently workable to allow proper placement without harmful segregation, bleeding, or incomplete consolidation.

Air-entraining admixtures will be required for all classes of concrete placed above an elevation of 3,000 feet, except for precast, prestressed structural members. The amount of entrained air in the concrete mixture shall not be less than four percent nor more than seven percent by volume.

For elevations below 3,000 feet, air-entraining admixtures may be used at the option of the contractor and the amount of entrained air in the concrete shall not exceed seven percent by volume.

Concrete that fails to conform to the entrained air content requirements listed above for the respective elevation as determined by the Engineer, shall be rejected prior to placement.

Unless specifically required, water reducing admixtures may be used at the option of the contractor.

TABLE 1006-A

Class of Concrete	Hydraulic Cement: Lbs per Cu Yd Minimum-Maximum	Slump Range, Inches	28-Day Compressive Strength Required: psi
P	564	0 - 4.5	4,000
S	564 - 752	-----	-------
B	517 - 658	-----	2,500

The minimum and maximum weights of hydraulic cement required are shown on Table 1006-A for each class of concrete. A fly ash admixture may be used at the option of the contractor only when Portland cement is used. A maximum of 20 percent of the

required weight of Portland cement may be replaced with a fly ash admixture. A minimum of 1.2 pounds of fly ash shall replace each 1.0 pounds of Portland cement removed.

Class S concrete shall have a compressive strength not less than that shown on the plans. Unless otherwise shown on the plans, the minimum required 28-day compressive strength of Class S concrete shall be f'_c = 3,000 pounds per square inch. Classes B and P concrete shall have minimum 28-day strengths of not less than that shown in Table 1006-A. Testing for compressive strength of cylinders shall be in accordance with the requirements of Arizona Test Method 314.

The coarse aggregate size designation for Classes S and B concrete shall be chosen by the contractor and approved by the Engineer and shall conform to the size designation and grading requirements of AASHTO M 43. In choosing the size designation, the maximum size of coarse aggregate shall not be larger than one fifth of the narrowest dimension between sides of adjacent forms, or two thirds of the minimum clear spacing between reinforcing bars, or one third the depth of the slab, whichever is least. If two or more stockpiles are utilized to manufacture an AASHTO M 43 size designation, at the time of proportioning for mixing, the aggregate from each stockpile shall be measured by weight and proportioned so that the resulting mixture of coarse aggregate meets the requirements for the chosen size designation.

Coarse aggregate for Class P concrete used to construct Portland cement concrete pavement without load transfer dowels shall be separated into two stockpiles. At the time of proportioning for mixing, the aggregate from each stockpile shall be measured by weight and proportioned so that the resulting mixture of coarse aggregate meets the requirements for size designation No. 467. The percent of fractured coarse aggregate particles for this coarse aggregate composite shall be at least 30 when tested in accordance with the requirements of Arizona Test Method 212.

Coarse aggregate for Class P concrete used to construct Portland cement concrete pavement with load transfer dowels and adjacent shoulders shall meet the requirements for size designation No. 57. The percent of fractured coarse aggregate particles shall be at least 30 when tested in accordance with the requirements of Arizona Test Method 212.

Coarse aggregate for Class P concrete placed in pavement ramp tapers not exceeding a width of 10 feet and in pavement gore areas may be size designation No. 57. The use of size designation No. 57 coarse aggregate may be used in concrete placed in other inaccessible pavement areas when approved in writing by the Engineer.

Concrete to be placed under water, tremie concrete, shall conform to the requirements for the class required except that the minimum hydraulic cement content shall be increased by 47 pounds per cubic yard of concrete.

1006-3.02 Design Procedures:

At least two weeks prior to the appropriate concreting operation, the contractor shall furnish a mix design for each class of concrete and each strength of Class S concrete for review and approval. More than one mix design for each class of concrete and each strength of

Class S concrete may be submitted for approval provided specific items and locations of intended uses accompany the mix design. The contractor shall substantiate each mix design by furnishing test data and providing all details of the mixtures proposed for use. The mix design shall be prepared under the direct supervision of, and signed by, a registered professional engineer, a NICET Level III or higher certified technician in the concrete subfield, or an ACI certified Concrete Laboratory Testing Technician Grade II. Individuals preparing and submitting mix designs shall have experience in the development of mix designs and mix design testing.

The complete solid volume mix designs submitted for approval shall include all weights and volumes of all ingredients. The brand, type, and source of hydraulic cement and admixtures, the coarse aggregate size number designation, source of aggregates, the specific gravities of all ingredients, the proposed slump, a code number to identify the mix design, and the intended use of each mix design shall be an integral part of each mix design.

Changes in approved mix designs or code numbers may be made by the contractor with the approval of the Engineer. In no case shall the approval of a mix design relieve the contractor of the responsibility for the results obtained by the use of such approved mix design.

Mix designs from previous or concurrent projects may be submitted for approval. The Engineer may waive trial batches at any time.

Prequalification of new mix designs by testing of trial batches will be required. For each trial batch, the materials, mixing equipment, procedures, and size of batch shall be the same as that to be used in the work.

The number of trial batches required will be determined by the Engineer. Samples for testing will be taken by the Engineer. A new mix design shall be submitted for approval any time the test results of an approved mix design indicate that the concrete will not meet the required 28-day compressive strength.

When approved by the Engineer, concrete from trial batches may be used in the work at locations where concrete of a lower strength is required and such concrete will meet the requirements of the class of concrete at that location. The basis of payment for such concrete shall be that which applies to the concrete required at that location.

1006-4 Concrete Production:

1006-4.01 General Requirements:

The contractor may obtain concrete for each Class of concrete and for each strength of Class S concrete from an approved commercial source in lieu of establishing a batch plant at the project site.

For each class of concrete and each strength of Class S concrete, except for Class P concrete produced in a batch plant at the site and used exclusively for Class P work, the

contractor shall furnish an invoice for each batch of concrete. The minimum information to be shown on each invoice shall be the date, time batched, truck identification number, name or identification of batch plant, name of contractor, name and location of project, the volume of concrete, the batch weights or mix design code number, the estimated percent of free moisture in the coarse and fine aggregates, the amount of any water withheld during batching, and the number of revolutions that the concrete has been mixed at mixing speed in a truck mixer. An authorized representative of the contractor shall be responsible for each invoice and shall sign each invoice accepting the contractor's responsibility for the concrete as the concrete is being placed. The representative shall immediately furnish the invoice to the Engineer.

1006-4.02 Proportioning:

(A) Cement:

Separate scales, positioned so as to be easily visible to the Engineer and accurate to ± 0.2 percent of scale capacity, shall be provided to weigh all hydraulic cement. The batching accuracy shall be within ± 1.0 percent of the required weight. Dial scales or a load cell providing a digital printed readout will be required to weigh all hydraulic cement.

The cement shall be conveyed by means of an enclosed conveying system and the weighing hopper shall be equipped with one or more vibrators as required to insure the complete discharge of all cement from the hopper after each batch is weighed.

(B) Water:

Water shall be measured by volume or by weight. Measurement by volume will be by metering.

Scales shall be accurate within ± 0.2 percent of scale capacity. Volumetric measuring devices shall have an accuracy of ± 1.5 percent. The batching devices shall be capable of routinely batching water within ± 1.5 percent.

(C) Aggregates:

All aggregates shall be proportioned by weight.

Suitable dial scales shall be provided by the contractor to weigh each size of aggregate. The scales shall be positioned so as to be easily visible to the Engineer and accurate to ± 0.2 percent of scale capacity. The batching accuracy shall be within ± two percent of the required weight. The weighing equipment shall be arranged so as to permit the convenient removal of excess material from the weighing hopper and the equipment shall be arranged to enable the operator to have convenient access to all controls. The scales shall be so equipped and the dials so graduated that the weights of materials being weighed can be accurately determined. Every expedient shall be used to obtain and preserve uniform moisture content in the coarse and fine aggregates. The moisture content shall not vary more than three percent during any day's production. The estimated percent of free

moisture in each of the coarse and fine aggregates shall be determined by the contractor using acceptable test methods.

The moisture content of the aggregate shall be such that no free drainage of water from the aggregate will be visible during transportation from the stockpile to the point of mixing. Aggregate containing excess moisture shall be stockpiled prior to use until it is sufficiently dry to meet the above requirement.

In the event that either the coarse or fine aggregate has a moisture absorption rate of more than 1.5 percent, the materials shall be thoroughly prewetted and allowed to drain in advance of use until the moisture content is stable.

(D) Admixtures:

The equipment and the procedures used to measure admixtures and dispense them into the concrete batch shall be approved by the Engineer prior to use.

Dry admixtures shall be measured by weight, with a separate dial scale positioned so as to be easily visible to the Engineer and accurate to within ± 1.0 percent of the amount being weighed. Paste or liquid admixtures shall be measured either by weight or by volume. Only mechanical dispensing equipment shall be used for adding admixtures. Dosage rates shall conform to the manufacturer's recommendations or approved rates, or as determined from field trial batches.

Dispensers for admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Unless liquid admixtures are added to premeasured water for the batch, their discharge into the batch shall be arranged to flow into the stream of water or on the fine aggregate. The amount of liquid admixtures shall not vary from the required amount by more than ± 5.0 percent.

Equipment for measurement shall be designed for convenient confirmation of measurement accuracy. If more than one liquid admixture is used, each admixture shall be dispensed by separate equipment unless otherwise permitted in writing by the Engineer.

Separate dial scales, positioned so as to be easily visible to the Engineer and accurate to ± 0.2 percent of scale capacity, shall be provided to weigh all fly ash admixtures. The batching accuracy shall be within ± 1.0 percent of the required weight.

Weighing of a fly ash admixture may be accomplished by the use of the hydraulic cement scales if proposed by the contractor and approved in writing by the Engineer.

The fly ash admixture shall be conveyed by means of an enclosed conveying system and the weighing hopper shall be equipped with one or more vibrators as required to insure the complete discharge of all fly ash from the hopper after each batch is weighed.

1006-4.03 Mixing:

(A) General Requirements:

The concrete may be mixed in a stationary mixer, either at a central mixing plant or at the site or it may be mixed in a truck mixer, either at a central mixing plant or at the site. Concrete may be mixed in a mobile mixer at the site for Class S and Class B concrete, provided written permission of the Engineer is granted.

Each mixer shall meet the specified requirements for type and size and shall have attached in a prominent place a manufacturer's plate showing the gross volume of the mixer and the recommended speeds of the mixer for mixing and for agitating.

Each batch plant shall be equipped to control the time when the water enters the mixer during the mixing cycle. Batch and mixing time shall be from the time hydraulic cement is combined with water.

Mixers shall be cleaned at suitable intervals. Water used for cleaning the mixer shall be discharged prior to further batching.

Equipment having components made of aluminum or magnesium alloys, which would have contact with plastic concrete during mixing and transporting, shall not be used.

All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of undispersed cement.

(B) Mixing in a Stationary Mixer:

After measurement is made of the materials in the required proportions and amounts, the batch of concrete materials shall be placed in the mixer. The flow of water into the mixer shall be uniform with a portion of the water entering in advance of the cement and aggregates and all of the water entering within the first 15 seconds of the mixing time.

The volume of concrete mixed per batch shall not exceed the capacity of the mixer as shown on the manufacturer's plate. No spillage of concrete will be allowed during the process of mixing.

While mixing, the mixer shall be operated at the speed shown on the manufacturer's plate as the mixing speed.

The mixing time shall not be less than 60 seconds per batch on Class P concrete and the mixing time shall be increased if directed by the Engineer. The mixing time shall be not less than 60 seconds for one cubic yard and shall be increased 15 seconds for each additional cubic yard or fraction thereof for Class S and Class B concrete.

The mixers shall have an automatic timing device which locks the discharge equipment until the required mixing time has been completed. The mixer shall be operating at mixing speed at the time that all ingredients enter the mixer to insure the immediate beginning of the mixing cycle. Mixing time shall end when the discharge chute opens. The contents of the mixer shall be completely discharged before the succeeding batch is placed in the mixer.

Any concrete discharged before the mixing time is completed shall be disposed of by the contractor at no additional cost to the Department.

Stationary mixers shall be equipped with automatic batch meters for counting the batches for Class P concrete. The contractor shall furnish the batch count daily to the Engineer.

Mixed concrete shall be transported in truck mixers, truck agitators or in nonagitating trucks having special bodies.

When truck mixers or truck agitators are used, the concrete shall be continuously agitated from the time of loading until the time of discharge. Agitation shall be by rotation of the drum at the speed shown on the manufacturer's plate as agitating speed.

The truck mixer or truck agitator shall be loaded and operated within a capacity not to exceed 80 percent of the gross volume of the drum. The rate of discharge shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully opened.

Discharge from the truck mixer or truck agitator shall be completed within 90 minutes from the time batched.

Bodies of nonagitating trucks shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. If discharge of concrete is accomplished by tilting the body, the surface of the load shall be retarded by a suitable baffle. Covers shall be provided when needed for protection.

Discharge from nonagitating trucks shall be completed within 45 minutes from the time concrete is batched. Concrete hauled in open-top vehicles shall be protected against access of rain, or exposure to the sun for more than 30 minutes when the ambient temperature exceeds 85 degrees F.

(C) Mixing in Truck Mixers:

Truck-mixed concrete shall be mixed entirely in the truck mixer and shall be mixed at the batch plant or at the site.

Truck mixers shall be operated within a capacity not to exceed 63 percent of the gross volume of the drum and at speeds shown on the manufacturer's plate as mixing and agitating speeds.

Each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum at mixing speed after all materials have been loaded into the drum, except that when approved by the Engineer, the maximum of 100 revolutions may be increased. Any revolving of the drum beyond the maximum number of revolutions shall be at the agitating speed. Mixing shall begin within 10 minutes after the cement has been combined with either the aggregate or water.

The truck mixer shall be equipped with an electrically or mechanically activated revolution counter by which the number of drum revolutions may be verified. The counter shall be of the "continuous registering" type, which accurately registers the number of revolutions. It shall be mounted on the truck mixer or just inside the truck cab, so that it may be safely and conveniently read from beside the truck. The revolution counter shall be reset to zero after all materials have been loaded into the drum.

Discharge from the truck mixer shall be completed within 90 minutes from the time batched.

If additional mixing water is required to maintain the specified slump, the concrete shall be mixed by a minimum of 20 revolutions of the drum at mixing speed after the water has been added, prior to discharge of any concrete for placement. Any additional mixing water and required mixing revolutions shall be recorded on the invoice specified in Subsection 1006-4.01. This additional mixing may be in excess of the maximum revolutions previously specified.

(D) Mixing in Mobile Mixers:

Concrete mixing in mobile mixers for Class S and Class B concrete shall be performed in accordance with the requirements of AASHTO M 241.

1006-4.04 Consistency:

The contractor shall furnish Class P Concrete having a slump within the range specified in Table 1006-1.

The contractor shall furnish Class S and Class B concrete having the slump shown on the approved mix designs with a permissible variation of ± one inch; however, the permissible variation will be ± two inches when an approved high range water reducer conforming to type F or G requirements of AASHTO M 194 is used.

Concrete that fails to conform to the consistency requirements will be rejected.

When concrete is pumped, samples for consistency will be taken both as the concrete leaves the mixer and at the pump hose discharge. If the Engineer determines that there is a good correlation between the results of consistency tests on samples obtained from the mixer and from the pump hose, the Engineer may discontinue sampling from one of the sources; however, the Engineer may take periodic samples from both sources to verify the correlation of test results.

1006-5 Weather Limitation:

1006-5.01 General Requirements:

Under rainy conditions, placing of concrete shall be stopped before the quantity of surface water is sufficient to cause a flow or wash of the concrete surface or have a detrimental effect on the finished concrete and acceptance parameters.

Placing of concrete shall immediately cease if the hauling vehicles or any equipment or pedestrian traffic tracks mud on the prepared base or changes the allowable subgrade dimensional tolerances for Class P concrete and slabs placed on subgrade for Class S and Class B concrete.

1006-5.02 Hot Weather Concreting:

The temperature of the concrete mixture immediately before placement shall not exceed 90 degrees F.

Concrete that fails to conform to the maximum temperature requirement in hot weather when the air temperature is above 90 degrees F and rising, shall be rejected prior to placement.

Forms, subgrade and reinforcing steel, shall be sprinkled with cool water just prior to placement of concrete.

Mix water may be cooled by refrigeration, liquid nitrogen, or well-crushed ice of a size that will melt completely during the mixing operation. Crushed ice may be substituted for part of the mix water on a pound for pound basis.

1006-5.03 Cold Weather Concreting:

The temperature of the mixed concrete immediately before placing shall not be less than 50 degrees F.

Concrete that fails to conform to the minimum temperature requirement in cold weather when the air temperature is below 50 degrees F and lowering, shall be rejected prior to placement.

Concrete shall not be placed on or against ice-coated forms, reinforcing steel, structural steel, conduits or construction joints, nor on or against snow, ice, or frozen earth materials.

Concrete operations shall be discontinued when a descending air temperature in the shade and away from artificial heat falls below 40 degrees F nor shall concrete operations be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35 degrees F unless otherwise approved by the Engineer.

Mixing and placing concrete shall continue no later in any day than that time which will allow sufficient time to place and protect the concrete already poured before the air temperature drops to 35 degrees F.

Concrete operations may be allowed although the air temperature at any time during the cure period in the shade and away from artificial heat is below the limit permitted above. Where concrete operations are thus allowed, the contractor shall use equipment to heat the aggregates or water, or both, prior to mixing. If aggregates are heated, the minimum temperature shall be 60 degrees F and the aggregates shall have no chunks of ice or frozen aggregate present. Equipment used to heat the aggregates shall be such that

consistent temperatures are obtained throughout the aggregate within each batch and from one batch to another. Water shall not be heated in excess of 150 degrees F unless the water is mixed with the aggregate prior to the addition of cement to the batch.

When concreting operations are allowed when the air temperature falls below the limits permitted in the shade and away from artificial heat, the contractor shall provide adequate insulation or heat, or both, to protect the concrete after placement. This protection shall be to the extent required to maintain a concrete surface temperature of not less than 50 degrees F for a period of 72 hours after placement and at not less than 40 degrees F for an additional 96 hours. When artificial heating is required, the heating units shall not locally heat or dry the surface of the concrete. A written outline of the proposed protection method shall be submitted to the Engineer for approval.

The placing of concrete will not be permitted until the Engineer is satisfied that all the necessary protection equipment and materials are on hand at the site and in satisfactory working condition.

Concrete requiring cold weather protection shall have such protection removed at the end of the required period in a manner that will permit a gradual drop in the concrete temperature.

1006-6 Curing Concrete:

1006-6.01 Curing Cast-in-Place Concrete:

(A) General Requirements:

All cast-in-place concrete shall be cured by one or by a combination of more than one of the methods specified herein and curing shall begin immediately after completion of machine or hand finishing of the fresh concrete.

Curing shall be continued for a period of at least seven days after placing if either Type II Portland cement or Portland pozzolan cement has been used, or for at least three days if Type III Portland cement has been used.

Surfaces requiring a Class II finish shall not be cured by the Liquid-Membrane Forming Compound Method until after the finishing operations are completed.

No traffic, hauling, storing of material or other work shall be allowed on any concrete surface during the required curing periods.

(B) Water Curing Method:

All surfaces not covered by reasonably waterproof forms shall be kept damp by applying water with a nozzle that so atomizes the flow of the water that a fog mist and not a spray is formed until the surface of the concrete is covered with a curing medium or sprinkling of the surface is permitted. The moisture from the nozzle shall not be applied under pressure

directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

If a curing medium is used, the concrete shall be kept continuously wet by sprinkling with water for the entire curing period. Burlap, rugs, carpets, or earth or sand blankets may be used as a curing medium to retain the moisture during the curing period. Application of the curing medium shall not begin until such time that placement can be made without marring the surfaces of the concrete.

If a curing medium is not used, the entire surface of the concrete shall be kept damp by the application of water with an atomizing nozzle as specified above until the concrete has set, after which the entire surface of the concrete shall be sprinkled continuously with water for the entire curing period.

In no case shall curing be interrupted by more than one hour during the curing period.

(C) Liquid-Membrane Forming Compound Method:

All surfaces not covered by reasonably waterproof forms shall be cured by the liquid-membrane forming compound method. The curing compound shall be applied to the concrete immediately following the surface finishing operation in one or more applications totaling a rate of not less than one gallon per 100 square feet.

The curing compound shall form a continuous unbroken surface.

If the membrane film is broken during the curing period, the broken area shall be given a new application of compound at the rate of one gallon per 200 square feet.

In no case shall curing be interrupted by more than one hour during the curing period.

(D) Forms in Place Method:

Formed surfaces of concrete may be cured by retaining the forms in place. The forms shall remain in place for the entire curing period.

All joints in the forms and the joints between the end of forms and concrete shall be kept moisture-tight during the curing period.

Cracks in the forms and cracks between the forms and the concrete shall be resealed by methods approved by the Engineer.

(E) Curing Bridge Deck:

The top surface of bridge decks shall be cured by the liquid-membrane forming compound method and by the water curing method. The curing compound shall be applied progressively immediately following the surface finishing operation. Liquid-membrane forming compound shall be applied at a rate of one gallon per 100 square feet. The curing compound shall form a continuous unbroken surface.

Water curing shall be applied not later than four hours after the completion of the deck finishing operations and shall be applied as specified herein.

The top surface of bridge decks that will be covered with a special riding surface or waterproofing membrane shall be cured by the water curing method only. Water curing shall be applied progressively immediately following the surface finishing operation as specified herein.

1006-6.02 Curing Precast Concrete:

(A) General Requirements:

The contractor may cure precast concrete in accordance with the requirements specified above for curing cast-in-place concrete or if it elects, the curing of precast concrete may be performed by external heating. This may be accomplished by the use of low-pressure steam or radiant heat with moisture.

If curing of the concrete is accomplished by low-pressure steam or radiant heat with moisture, curing will be considered completed after termination of steam or radiant heat curing. Rapid temperature changes in the concrete shall be avoided during the cooling period.

If curing of the concrete is accomplished by the water curing method, the liquid-membrane forming compound method, or the forms-in-place method, such curing shall be continued for a period of at least seven days after placement of the concrete. The curing time may be reduced to a minimum of three days when a Type III Portland cement has been used.

(B) Low-Pressure Steam Curing:

After placement of the concrete, precast items shall be held for a minimum two-hour presteaming period. If the ambient air temperature is below 50 degrees F, steam shall be applied during the presteaming period to hold the air surrounding the precast item at a temperature between 50 and 90 degrees F.

To prevent moisture loss on exposed surfaces during the presteaming period, precast items shall be covered as soon as possible after casting or the exposed surfaces shall be kept wet by fog spray or wet blankets.

Enclosures for steam curing shall allow free circulation of steam about the member and shall be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good repair and secured in such a manner to prevent the loss of steam and moisture.

Steam at the jets shall be low pressure and in a saturated condition. Steam jets shall not impinge directly on the concrete, test cylinders or forms. During application of the steam, the ambient air temperature rise within the enclosure shall not exceed 40 degrees F per hour. The average curing temperature throughout the enclosure shall not exceed

160 degrees F and shall be maintained at a constant level for a sufficient length of time so as to ensure the development of the required compressive strength by the age of 28 days in concrete items which are not be prestressed. For items which are to be prestressed, the constant temperature shall be maintained for sufficient time necessary to develop the concrete compressive strength required for prestressing. The ambient curing temperature shall not exceed 175 degrees F at any point. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature is representative of the average temperature of the enclosure.

Temperature recording devices that will provide an accurate continuous permanent record of the ambient curing temperature shall be provided. A minimum of two temperature recording devices or one for every 200 feet of continuous bed length will be required for checking temperature.

In the event the side forms are removed before the precast unit has attained the required release compressive strength, the curing method shall be continuous in maintaining the temperature and moisture level as described above, within the enclosure, as nearly as practical. There shall not be a delay in re-covering the girder or prestress member.

(C) Radiant Heat With Moisture:

Radiant heat shall be applied by means of pipes circulating steam, hot oil or hot water, or by heating elements or electric blankets on the forms. Pipes, blankets or elements shall not be in contact with the concrete surfaces.

Moisture shall be applied in such a manner as to keep the top surface of the precast unit continuously moist during the curing period by fogging or spraying. Moisture shall be maintained by a cover of burlap or cotton matting and further covered by a waterproof tarpaulin with an insulating cover.

Temperature limits and the use of recording thermometers shall be the same as curing with low-pressure steam. Application of the heat cycle may be accelerated to meet climatic conditions upon the approval of the Engineer. A temperature sensing device shall be placed two ± 1/2 inches from the heated form.

1006-7 Acceptance Sampling and Testing:

1006-7.01 General:

Rejection of concrete will occur due to improper temperature, slump, and/or air content for the concrete mixture delivered to the site. The Engineer may allow failed concrete mixture already placed to remain in place subject to acceptance by compressive strength or may require its removal.

Rejection of concrete will also occur due to insufficient compressive strength. Concrete compressive strength requirements consists of the specified strength which the concrete shall attain before various loads or stresses are applied and a minimum strength at 28 days.

Acceptance and penalties for placed concrete which meets the above mixture requirements or is allowed to remain in place shall be determined by the results of the 28-day compressive strength, and additionally in the case of Class P concrete, on the measured thickness of concrete pavement in place according to Section 401. Sampling and testing for compressive strength will be performed on all classes of concrete furnished, including each strength specified on the project plans for Class S concrete.

1006-7.02 Sampling and Testing of Concrete:

A sample of concrete for determination of temperature, slump, and air content as well as for fabrication of test cylinders for compressive strength determination at 28 days will be taken at random at the specified sampling frequency for each type of concrete.

Samples of concrete shall be of sufficient size to perform all the required tests and fabricate the necessary test cylinders. The samples shall be taken in accordance with the requirements of AASHTO T 141, except as follows:

(1) Concrete for Class S or B shall be sampled only once during discharge in the middle portion of the batch. At the discretion of the Engineer, a sample may be obtained at the beginning of the discharge if, in the Engineer's opinion, the properties of the concrete do not appear to be within the specification limits for slump or temperature.

(2) Concrete for Class P shall be sampled immediately before going into the paver or forms, or as otherwise directed by the Engineer.

If concrete is pumped to facilitate placement, at the discretion of the Engineer, samples may be taken from the truck and pump hose discharge to determine that the compressive strength specifications are met in the structure, and to correlate temperature, slump and air content results. If the correlation is satisfactory and meets with the approval of the Engineer, sampling may continue from the most convenient location with occasional re-testing for correlation. Rejection of concrete due to improper temperature or slump may occur at either the truck or pump hose discharge; however, rejection of concrete due to improper air content will only occur due to a failing test for a sample obtained at the final point of discharge.

Temperature of the concrete mixture will be determined in accordance with ASTM C 1064. Slump of the concrete mixture will be determined in accordance with AASHTO T 119. Air content of the concrete mixture will be determined in accordance with AASHTO T 152. All compressive strength test cylinders will be fabricated in accordance with the requirements of AASHTO T 23. Testing for compressive strength of cylinders shall be in accordance with the requirements of Arizona Test Method 314.

For Class B and Class S concrete, a strength test will consist of the average strength of two cylinders or 95 percent of the higher strength cylinder, whichever is greater.

For Class P concrete, the compressive strength of each sample shall be determined by averaging the results of the three test cylinders fabricated as specified in Subsection 1006-7.03. If, however, the compressive strength of any test cylinder differs by

more than 10 percent from the average of the three, its results shall be discarded and the compressive strength of the sample shall be the average of the remaining two cylinders. Should the compressive strength of two cylinders differ by more than 10 percent from the average of the three, the results of both will be discarded and the compressive strength of the sample shall be the strength of the remaining cylinder.

If, for purposes of improving a negative pay factor or acceptability, the contractor chooses to contest the compressive strength results of any sample, he may elect to rely on the results of compressive strengths of cores. Such results shall be obtained by coring, at the contractor's expense, at the approximate location where the contested test cylinders were obtained. Such cores shall be obtained and tested in accordance with AASHTO T 24, and will be tested in the wet condition. Cores must be obtained under the observation of an ADOT representative and submitted to an ADOT laboratory designated by the Engineer in time to allow complete testing within 42 days of placement. The contractor may elect to have a representative present during testing. Compressive strength shall be the average of the results of the three cores; however, if the strength of any core varies from the average of the three cores by more than 10 percent, the results of that core shall be discarded and the compressive strength of the sublot will be the average of the remaining two cores. Should the compressive strengths of two cores differ by more than 10 percent from the average of the three, both results shall be discarded and the compressive strength of the sample shall be the result of the remaining core. Results of the core testing will be binding on both the contractor and the Department, and will replace the results of the test cylinders for that sample.

1006-7.03 Sampling Frequency for Cast-In-place Concrete:

A sample of concrete for the required tests, as specified in Subsection 1006-7.02, will be taken on a daily basis for each 100 cubic yards, or fraction thereof, of continuously placed concrete, for Class B concrete and for each strength classification of Class S concrete, from each batch plant or source. At elevations above 3000 feet, a sample of concrete will be taken for each 50 cubic yards placed, for testing of air content. A sample for the required tests on daily placements of 20 cubic yards or less may be taken at the discretion of the Engineer. An additional sample or samples for any of the required tests may be taken, at an interval of less than 100 cubic yards, at the discretion of the Engineer on any batch or load of concrete. The Engineer will determine the quantity of concrete represented by each sample of concrete for any test performed.

Class P concrete shall be sampled and tested for compressive strength by the lot. A lot shall be considered to be one shift's production; however, a new lot shall begin when the mix design is changed. For partial shifts due to weather or other reasons, more than one day's production may be included in a lot. When such partial shifts occur, the contractor and the Engineer will jointly determine the lot limits. Five samples shall be obtained from each lot at random locations as directed by the Engineer. Three test cylinders shall be fabricated from each sample and tested for 28-day compressive strength in accordance with Subsection 1006-7.02.

Class P concrete shall be sampled and tested for temperature, slump, and air content (if applicable) a minimum of five times per lot. The frequency may be reduced for partial shifts

with the concurrence of the Engineer. Additional samples for any of the required tests may be taken at the discretion of the Engineer. The Engineer will determine the quantity of concrete represented by each sample of concrete for any test performed.

1006-7.04 Sampling Frequency for Precast Concrete:

A sample of concrete for the required tests as specified in Subsection 1006-7.02 will be taken for either each precast concrete member or for each day's production at the discretion of the Engineer, when the method of measurement is by the unit.

An additional sample or samples for any of the required tests may be taken at the discretion of the Engineer. The Engineer will determine the quantity of concrete represented by each sample of concrete for any test performed.

When a sample of concrete for the required compressive strength test is taken to represent a single day's production and not each precast member, the degree of acceptance for all precast concrete members in that day's production will be established by the results of such compressive strength test.

1006-7.05 Testing for Minor Precast Concrete Structures:

A strength test on each precast unit produced will consist of the average rebound number as determined from readings taken on the precast unit with a rebound hammer. The average rebound number will be determined in accordance with the requirements of ASTM C 805.

The compressive strength of the concrete will be determined from the average rebound number and the calibration chart established for the specific rebound hammer being used. The calibration chart will be established from rebound readings taken on concrete test cylinders fabricated at the precast plant and the actual compressive strength of the cylinders. The test cylinders will be fabricated in accordance with the requirements of AASHTO T 23. Testing for compressive strength of cylinders shall be in accordance with the requirements of Arizona Test Method 314.

1006-7.06 Acceptance for Compressive Strength:

(A) Class P Concrete:

Class P concrete will be accepted for compressive strength in accordance with the provisions of Section 401. All concrete failing to meet this requirement or otherwise rejected in accordance with Section 401 or Subsection 1006-7.01, shall be replaced with concrete meeting the requirements of these specifications.

(B) Class S and Class B Concrete:

Concrete represented by a strength test of at least 95 percent of the required 28-day compressive strength will be acceptable for cast-in-place and precast concrete. All concrete failing to meet this requirement or other requirements listed in

Subsection 1006-7.01 will be rejected in accordance with the provisions of Subsection 106.11 unless the contractor, at no additional cost to the Department, can submit evidence that will indicate to the Engineer that the strength and quality of the concrete is such that the concrete should be considered acceptable.

If such evidence consists of concrete cores, the contractor shall obtain three cores from the concrete represented by the failing strength test and deliver them to the Engineer in time to allow complete testing of such cores within 42 days after the placement of the concrete. All cores shall be obtained and tested in accordance with the requirements of AASHTO T 24. All cores will be tested in the wet condition. The concrete represented by the cores will be considered acceptable if the numerical average of the three tests is 95 percent of the required 28-day compressive strength. If the average compressive strength does not meet this requirement, all concrete so represented shall be removed at no additional cost to the Department unless permitted to remain in place by the Engineer. If the concrete is permitted to remain in place, when the average compressive strength of the three cores fails to meet 95 percent of the required 28-day compressive strength, it will be paid for at 55 percent of the contract price.

1006-8 Method of Measurement and Basis of Payment:

The method of measurement and basis of payment will be made under the provisions specified in the various sections of the specifications covering construction requiring the use of concrete.

SECTION 1007 RETROREFLECTIVE SHEETING:

1007-1 General Requirements:

Retroreflective sheeting shall consist of a retroreflective system having a smooth outer surface. The sheeting shall have a pre-coated adhesive on the back side protected by an easily removable liner. The sheeting shall conform to all criteria in the most current version of AASHTO M 268 for the applicable type and class or as modified herein. Retroreflective sheeting of the same color placed on the same sign panel or adjacent sign panels shall be color matched and be from the same manufacturing lot and run.

Only those sign sheeting products currently shown in the Department’s Approved Products List (APL) shall be utilized in the performance of this work. Copies of the most recent version of the APL are available on the internet at http://www.dot.state.az.us/ABOUT/atrc/apl.htm.

Manufacturer's identification marks shall be fabricated in, or on, the face of the various types of sheeting utilized. The markings shall be visible from a distance not greater than three feet, and the identification codes shall be furnished to the Engineer.

A Certificate of Compliance, conforming to the requirements of Subsection 106.05, shall be submitted.

1007-2 Reflective Materials Types:

Retroreflective sheeting shall meet the requirements of AASHTO M 268 for the types of sheeting called for in the project plans. The minimum criteria to be met are those established for Type II sheeting. Only those products which meet or exceed these requirements and which are listed in the Department's Approved Products List shall be used. The specific type of sheeting for each application shall be called for in the project plans. If no sheeting type is designated, the contractor shall furnish Type II sheeting.

1007-3 Color Requirements:

The color shall be as specified in the ADOT Manual of Approved Signs or on the project plans.

The Engineer may accept colors by certification or may require the contractor to furnish laboratory test results.

1007-4 Specific Intensity Per Unit Area (SIA):

The Specific Intensity per Unit Area (SIA) shall meet the minimum requirements of AASHTO M 268 for the type of sheeting called for in the Manual of Approved Signs or the project plans.

1007-5 Color Processing:

Color processing shall meet all requirements specified in AASHTO M 268. Opaque or transparent colors, inks and paints used in sign fabrication shall be of the type and quality as recommended by the manufacturer of the reflective sheeting. Only those products listed in the Approved Products List shall be used. Application will be by a screen process which results in uniform color and tone, possessing sharply defined edges of legend and border. Screen Mesh P.E. 157, using a fill pass, shall be used for applying transparent colors. After the ink is applied, the inked colors shall meet the minimum SIA requirements for the basic color and the type of sheeting being used.

1007-6 Adhesive:

The reflective sheeting shall include either Class 1 or Class 2 adhesive backing as specified in AASHTO M 268.

SECTION 1008 PRISMATIC REFLECTORS:

1008-1 General Requirements:

The contractor shall furnish a Certificate of Compliance in accordance with the requirements of Subsection 106.05. The certificate shall state that the reflectors comply in all respects with the following requirements:

The retroreflectors shall consist of a plastic face (herein referred to as the lens) and an opaque back fused to the lens (under heat and pressure) around the entire perimeter to form a homogeneous unit permanently sealed against dust, water, and water vapor. The retroreflector shall be clear (crystal) in color. The lens shall consist of a smooth front surface free from projections or indentations other than for identification and a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light. The manufacturer's trademark shall be molded legibly into the face of the lens.

The specific intensity of each acrylic retroreflector shall be equal to or exceed the minimum values in Table 1008-1 with measurements made with retroreflectors spinning.

1008-2 Delineator and Object Marker Retroreflectors:

The retroreflectors shall be either white, yellow, green, or red as specified and shall be ready for mounting.

The lens shall have a retroreflective area of not less than 6.5 square inches. Retroreflection shall be provided by the lens prismatic optical elements.

The following test shall be used to determine if a retroreflector is adequately sealed against dust, water or air.

Submerge 50 samples in water bath at room temperature. Subject the submerged samples to a vacuum of five inches gauge for five minutes. Restore atmospheric pressure and leave samples submerged for five minutes, then remove and examine the samples for water intake. Failure of three or more units shall be cause for rejection of the entire lot.

The delineator or object marker device shall consist of an acrylic plastic retroreflector unit mounted in a housing fabricated of 0.063-inch 3003-H-14 or similar aluminum, or of cold rolled, hot dip, galvanized steel, having a thickness of 0.064 inches. Housing dimensions, including assembly and post mounting hardware will be as shown on the plans or as specified in the contract. Attachment hardware shall permit easy removal with the proper tools, but that removal is not possible without the use of such tools.

The housing shall be protected against corrosion as recommended by the manufacturer.

1008-3 Cut-Out Letters, Symbols and Accessory Retroreflectors:

The retroreflectors shall be clear and transparent mounted as an integral part of the character. Five retroreflectors shall be submitted for test. Failure of one or more units shall constitute failure of the lot.

The sealed prismatic retroreflector units shall be tested for dust and water intrusion as follows:

- Submerge five retroreflectors in a water bath at room temperature. Subject the submerged units to a vacuum of five inches gauge (water) for

five minutes, then examine them for water intake. Failure of one or more units shall constitute failure of the lot.

- Three reflectors shall be tested for four hours in a circulating air oven at 175 ± five degrees F. The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the test, the retroreflectors shall be removed from the oven and permitted to cool in air to room temperature. The units, after exposure to heat and air cooling, shall show no significant change in shape and general appearance when compared with unexposed control standards. Failure of one or more units shall constitute failure of the lot.

- The assembled cut-out letter, symbol, or accessory shall withstand the combined corrosion test set forth in ASTM B 117. No failures permitted.

TABLE 1008-1
(Candelas per Footcandle per Square Inch)
Minimum Specific Intensity Per Unit Area (SIA):

Reflector Units						
Observation Angle:	Entrance Angle:	Delineators & Object Markers				Cutout Letters, Symbols & Access.
(Degrees)	(Degrees)	*White	Yellow	Green	Red	Colorless
0.1	0	17.7	6.5	4.6	4.6	14.0
0.1	20	6.9	3.8	1.8	1.8	5.6
0.33	0	-	-	-	-	10.0
0.33	20	-	-	-	-	4.0
0.17	0	-	-	-	-	7.0
0.17	20	-	-	-	-	2.8
* Crystal, Clear, or Colorless						

SECTION 1009 ASPHALT-RUBBER MATERIAL:

1009-1 Description:

The work under this section shall consist of furnishing, proportioning and mixing all the ingredients necessary to produce an asphalt-rubber material.

1009-2 Materials:

1009-2.01 Asphalt-Rubber:

(A) Asphalt Cement:

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005.

(B) Rubber:

Rubber shall meet the following gradation requirements when tested in accordance with Arizona Test Method 714.

Sieve Size	Percent Passing	
	Type A	Type B
No. 8	100	
No. 10	95 - 100	100
No. 16	0 - 10	65 - 100
No. 30		20 - 100
No. 50		0 - 45
No. 200		0 - 5

The rubber shall have a specific gravity of 1.15 ± 0.05 and shall be free of wire or other contaminating materials, except that Type A rubber shall contain not more than 0.1 percent fabric and Type B shall contain not more than 0.5 percent fabric. Calcium carbonate, up to four percent by weight of the granulated rubber, may be added to prevent the particles from sticking together.

Certificates of Compliance conforming to Subsection 106.05 shall be submitted. In addition, the certificates shall confirm that the rubber is a crumb rubber, derived from processing whole scrap tires or shredded tire materials; and the tires from which the crumb rubber is produced are taken from automobiles, trucks, or other equipment owned and operated in the United States. The certificates shall also verify that the processing does not produce, as a waste product, casings or other round tire material that can hold water when stored or disposed of above ground.

1009-2.02 Asphalt-Rubber Proportions:

The asphalt-rubber shall contain a minimum of 20 percent ground rubber by the weight of the asphalt cement.

1009-2.03 Asphalt-Rubber Properties:

Asphalt-rubber shall conform to the following:

Property	Requirement		
	Type 1	Type 2	Type 3
Grade of base asphalt cement	PG 64-16	PG 58-22	PG 52-28
Rotational Viscosity*: 350 ^{o}F; pascal seconds	1.5 - 4.0	1.5 - 4.0	1.5 - 4.0
Penetration: 39.2 ^{o}F, 200 g, 60 sec. (ASTM D 5); minimum	10	15	25

Property	Requirement		
	Type 1	Type 2	Type 3
Softening Point: (ASTM D 36); ^{o}F, minimum	135	130	125
Resilience: 77 ^{o}F (ASTM D 5329); %, minimum	30	25	15
* The viscotester used must be correlated to a Rion (formerly Haake) Model VT-04 viscotester using the No. 1 Rotor. The Rion viscotester rotor, while in the off position, shall be completely immersed in the binder at a temperature from 350 to 355 degrees F for a minimum heat equilibrium period of 60 seconds, and the average viscosity determined from three separate constant readings (± 0.5 pascal seconds) taken within a 30 second time frame with the viscotester level during testing and turned off between readings. Continuous rotation of the rotor may cause thinning of the material immediately in contact with the rotor, resulting in erroneous results.			

1009-2.04 Asphalt-Rubber Design:

At least two weeks prior to the use of asphalt-rubber, the contractor shall submit an asphalt-rubber design prepared by an approved laboratory. Such design shall meet the requirements specified herein. The design shall show the values obtained from the required tests, along with the following information: percent, grade and source of the asphalt cement used; and percent, gradation and source(s) of rubber used.

1009-3 Construction Requirements:

During production of asphalt-rubber, the contractor shall combine materials in conformance with the asphalt-rubber design unless otherwise approved by the Engineer.

1009-3.01 Mixing of Asphalt-Rubber:

The temperature of the asphalt-cement shall be between 350 and 400 degrees F at the time of addition of the ground rubber. No agglomerations of rubber particles in excess of two inches in the least dimension shall be allowed in the mixing chamber. The ground rubber and asphalt-cement shall be accurately proportioned in accordance with the design and thoroughly mixed prior to the beginning of the one-hour reaction period. The contractor shall document that the proportions are accurate and that the rubber has been uniformly incorporated into the mixture. Additionally, the contractor shall demonstrate that the rubber particles have been thoroughly mixed such that they have been "wetted." The occurrence of rubber floating on the surface or agglomerations of rubber particles shall be evidence of insufficient mixing. The temperature of the asphalt-rubber immediately after mixing shall be between 325 and 375 degrees F. The asphalt-rubber shall be maintained at such temperature for one hour before being used.

Prior to use, the viscosity of the asphalt-rubber shall be tested by the use of a rotational viscotester, which is to be furnished by the contractor or supplier.

1009-3.02 Handling of Asphalt-Rubber:

Once the asphalt-rubber has been mixed, it shall be kept thoroughly agitated during periods of use to prevent settling of the rubber particles. During the production of asphaltic concrete the temperature of the asphalt-rubber shall be maintained between 325 and 375 degrees F. However, in no case shall the asphalt-rubber be held at a temperature of 325 degrees F or above for more than 10 hours. Asphalt-rubber held for more than 10 hours shall be allowed to cool and gradually reheated to a temperature between 325 and 375 degrees F before use. The cooling and reheating shall not be allowed more than one time. Asphalt-rubber shall not be held at temperatures above 250 degrees F for more than four days.

For each load or batch of asphalt-rubber, the contractor shall provide the Engineer with the following documentation:

(1) The source, grade, amount and temperature of the asphalt cement prior to the addition of rubber.

(2) The source and amount of rubber and the rubber content expressed as percent by the weight of the asphalt cement.

(3) Times and dates of the rubber additions and resultant viscosity test.

(4) A record of the temperature, with time and date reference for each load or batch. The record shall begin at the time of the addition of rubber and continue until the load or batch is completely used. Readings and recordings shall be made at every temperature change in excess of 20 degrees F, and as needed to document other events which are significant to batch use and quality.

SECTION 1010 DRAINAGE PIPE:

1010-1 General Requirements:

Certificates of Compliance shall be furnished in accordance with the requirements of Subsection 106.05.

1010-2 Metal Pipe:

1010-2.01 Corrugated Metal Pipe:

Type 1A pipe, as specified in AASHTO M 36, Section 4.1.2, may be used if the shell thickness meets or exceeds the thickness specified on the plans for Type 1 pipe.

Metallic coated (zinc or aluminum) corrugated iron or steel culverts, underdrains, and spiral rib corrugated steel pipe shall conform to the requirements of AASHTO M 36, except as otherwise noted herein.

Polymer precoated, metallic coated (zinc or aluminum) corrugated steel culverts and underdrains shall conform to the requirements of AASHTO M 245, except as otherwise noted herein.

Bituminous coated corrugated metal (metallic coated steel or aluminum) culverts and underdrains shall conform to the requirements of AASHTO M 190.

Aluminum alloy corrugated metal pipe shall conform to the requirements of AASHTO M 196.

The types of bituminous coating and the type of precoated sheets to be used will be specified on the project plans. In lieu of the Type A bituminous coating, the pipe shall be coated either in the field or at the plant on the outside surface only in accordance with the requirements of AASHTO M 243. Either asphalt mastic or tar base material shall be used.

Coupling bands shall conform to the requirements of AASHTO M 36, M 245 and M 196, except that the use of bands with projections (dimples) will be limited to connection of new pipe to existing in-place pipe. Bands of special design that engage factory reformed ends of corrugated metal pipe may be used.

Bolts and nuts for all types of coupling bands shall conform to the requirements of ASTM F 568.

Coupling band connection hardware consisting of nuts, bolts, rods, bars, and rivets shall be either galvanized after fabrication by the hot-dip process in accordance with the requirements of ASTM A 153 or coated by the electroplating process in accordance with the requirements of ASTM B 633 or ASTM B 766. Components of bolted assemblies shall be galvanized in accordance with ASTM A 153 separately before assembly.

Special sections, such as elbows and prefabricated end sections, shall conform to the applicable requirements of AASHTO M 36, M 190, M 196 and M 245.

Gaskets for all water-resistant joints shall be a continuous band or strip, at least seven inches wide and one half inch thick. Rubber for the gaskets shall conform to the requirements of ASTM D 1056 for the "2A" closed cell expanded grades.

Watertight joints shall use "O"-ring gaskets. The “O”-ring gasket shall conform to the diameter dimensions specified in AASHTO M 36, Section 9.3, and conform to the technical requirements of AASHTO M 198. Watertight joints may be used when water-resistant joints are specified.

1010-2.02 Spiral Rib Metal Pipe:

Spiral rib metal pipe shall conform to the requirements specified under Subsection 1010-2.01 for corrugated metal pipe, except as modified herein:

(A) Fabrication:

Ribbed steel pipe shall be fabricated with a continuous helical lock seam in accordance with AASHTO M 36, Type 1R or corrugation in accordance with AASHTO M 196, Type 1R. Aluminum rib pipe shall be manufactured in accordance with AASHTO M 196, Type 1R.

Each pipe end shall be fabricated with a minimum of two annular rerolled corrugations for the purposes of joining pipes together with band couplers.

(B) Coatings:

The types of coatings and the type of precoated sheets to be used shall be as specified on the project plans.

(C) Coupling Bands:

Coupling bands for spiral ribbed steel pipe shall be rerolled bands manufactured from 0.064-inch thick metallic-coated steel conforming to the requirements specified under Subsection 1010-2.01 and shall be two-piece for pipe greater than 48 inches in diameter.

Coupling bands shall be a minimum of 10-1/2 inches wide, formed with two corrugations that are spaced to provide nesting in the second corrugation of each pipe end and shall be drawn together by a minimum of two 1/2-inch diameter galvanized bolts through the uses of a bar and strap suitably welded to the band. Bands may be drawn together by other means, such as angles, as approved by the Engineer.

(D) Fittings:

Fittings for ribbed steel pipe shall conform to the requirements for corrugated steel pipe fittings specified in Subsection 1010-2.01, except the material shall be ribbed steel.

(E) Miscellaneous:

All spiral rib manhole risers 24 inches in diameter or greater shall be reinforced with a rolled three-inch by three-inch by 1/4-inch angle or as approved by the Engineer.

Pipe thickness for spiral rib pipe shall be specified in the pipe summary, but shall not be less than that listed in the following tables:

SPIRAL RIB METALLIC COATED STEEL PIPE		
Pipe Diameter, Inches	**Minimum Thickness, gage**	**Corrugation Rib Size, Inches**
18 - 60	16	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2
66 - 78	14	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2
84 - 102	12	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2

SPIRAL RIB ALUMINUM PIPE		
Pipe Diameter, Inches	**Minimum Thickness, Gage**	**Corrugation Rib Size, Inches**
18 - 42	16	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2
48 - 54	14	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2
60 - 72	12	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2
78 - 84	10	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2

1010-2.03 Concrete-Lined Corrugated Metal Pipe:

(A) Corrugated Metal Pipe:

Corrugated metal pipe, coupling bands and fittings for concrete-lined pipe shall conform to the requirements of AASHTO M 36 for the specified sectional dimensions and metallic coatings. Aluminized coating shall conform to AASHTO M 274.

Pipe shall be full circle and shall be fabricated with helical corrugations.

Pipe thickness shall be as specified in the pipe summary, but shall not be less than that listed in the following table:

Pipe Diameter, Inches	**Minimum Thickness, Inches (Gage)**	**Corrugation Rib Size, Inches**
12 - 48	0.064 (16)	2-2/3 by 1/2
54 - 72	0.064 (16)	2-2/3 by 1/2 3 by 1 5 by 1
78 - 84	0.079 (14)	2-2/3 by 1/2 3 by 1 5 by 1
90 - 102	0.109 (12)	2-2/3 by 1/2 3 by 1 5 by 1
108 - 120	0.138 (10)	3 by 1 5 by 1

Each pipe end shall be fabricated with a minimum of two annular rerolled corrugations for purposes of joining pipes together with band couplers.

Pipe shall be joined with rerolled bands made from the same material as the pipe. The bands shall be a minimum of 16 gage (0.064 inches) thick. Bands shall be two-piece for pipe greater than 48 inches in diameter.

Coupling bands shall be a minimum of 10-1/2 inches wide, formed with two (2) corrugations that are spaced to provide nesting in the second corrugation of each pipe end and shall be drawn together by a minimum of two 1/2-inch diameter galvanized bolts through the use of a bar and strap suitably welded to the band. Bands may be drawn together by other means, such as angles, as approved by the Engineer.

When watertight joints are specified, "O" ring gaskets will be required. "O" ring gaskets shall be per ASTM C 361 Section 5.9 and shall be placed in the first corrugation of each pipe end and shall be compressed by tightening the coupling band, in accordance with the manufacturers installation instructions.

(B) Concrete Lining:

(1) Composition:

Concrete for the lining shall be composed of cement, fine aggregate and water that are well mixed and of such consistency as to produce a dense, homogeneous, non-segregating lining.

(2) Cement:

Portland cement shall be in accordance with Subsection 1006-2.01.

(3) Aggregate:

Aggregates shall conform to AASHTO M 6, except that the requirements for gradation and uniformity of gradation shall not apply.

(4) Mixture:

The aggregates shall be sized, graded, proportioned and thoroughly mixed with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the pipe will conform to the design requirements of this specification. In no case, however, shall the proportions of Portland cement plus pozzolanic admixture be less than 470 pounds per cubic yard of concrete.

(5) Lining:

The lining shall have a minimum thickness of 3/8 inch above the crest of the corrugations and shall be applied by a machine traveling through a stationary pipe. The rate of travel of the machine and the rate of concrete placement shall be mechanically regulated so as to produce a homogeneous non-segregated lining throughout. The lining shall be applied in a two-course application and shall be mechanically troweled by the lining machine as the unit moves through the pipe. The trowel attachment shall be such that the pressure applied to the lining will be uniform and shall produce a lining that has a uniform thickness and a consistent troweled finish. The vertical diameter anywhere inside the pipe must be

95 percent of the nominal diameter less acceptable tolerances as stated in AASHTO M 36. Pipe not meeting these tolerances with be rejected.

(C) Experience:

The manufacturer shall certify in writing that it has successfully manufactured and furnished corrugated steel pipe with a concrete lining per these specifications on a minimum of fifteen (15) previous projects of a storm sewer nature.

1010-3 Slotted Pipe:

Slotted pipe shall conform to the applicable requirements of AASHTO M 36. It shall be the grate slot or angle slot type. Pipe shall be helically or annular corrugated.

Grate assemblies shall be fabricated from steel conforming to the requirements of either ASTM A 36 or A 576 and shall be galvanized in accordance with the requirements of ASTM A 123. The method of manufacture shall relieve all strain and prevent distortion of the pipe.

When a lockseam joint is used, slotted drain pipe shall be placed in a clamping device and cut the entire length prior to placement of the grate. The grate must be continuous and full depth. The grate shall be welded continuously to the pipe with a 3/16 inch fillet weld from end to end on both sides.

Bolts and nuts shall be steel conforming to the requirements of ASTM F 568 and shall be galvanized in accordance with the requirements of ASTM A 123.

The butyl rubber joint sealant material shall be an extruded strip or bead compounded from a nondrying, nontoxic, synthetic resin base with butyl rubber and inorganic extenders and be 100 percent solid material with no shrinkage. The sealant material shall have sufficient adhesion so that the strip or bead will adhere to galvanized steel and be soft enough to allow cold flow when compressed during connection of the pipe sections. The sealant material shall not flow or sag at temperatures up to 180 degrees F nor become brittle, crack or lose adhesion at temperatures as low as -30 degrees F and shall contain no migrating components that could leach out or produce any chemical reaction with galvanized steel. The sealant material shall be furnished in 5/8 inch by one inch strips or in one inch diameter beads on one inch wide release paper and wound into rolls.

An alternative joint sealant or sealing method that will provide a watertight joint may be used if approved by the Engineer.

Materials used for grout shall conform to the requirements of Section 1006. The grout shall be composed by volume of one part Portland cement, three parts fine aggregate and one-fifth part hydrated lime. Hydrated lime shall conform to the requirements of ASTM C 207, Type N. To these mixed materials sufficient water shall be added to provide a mixture that will flow readily. Grout that has been mixed more than one hour shall not be used. Retempering of grout will not be permitted.

1010-4 Structural Plate Pipe:

Structural plate (steel) for pipe, pipe-arches and arches and the accessories for connecting the plates shall conform to the requirements of AASHTO M 167.

Structural plate (aluminum alloy) for pipe, pipe arches and arches and the accessories for connecting the plates shall conform to the requirements of AASHTO M 219.

When specified on the project plans or in the Special Provisions, structural plates (steel) and structural plates (aluminum alloy) shall be bituminous coated in accordance with the requirements of AASHTO M 243. Unless otherwise specified, the coating shall be applied to the outside only.

Concrete for footings, bottom slabs on paved inverts, and rings on struts shall conform to the requirements of Section 1006 for the strength and class specified on the project plans.

Steel bars, wire, wire fabric, anchor bolts, and structural steel shall conform to the requirements of Section 1003 or 1004, as applicable.

1010-5 Nestable Steel Pipe:

Nestable corrugated steel pipe shall conform to the requirements of AASHTO M 36, except that the pipe shall be fabricated in two separate semi-circular sections. The two sections shall be firmly joined together in accordance with the requirements of Military Specification MIL-P-236. At the option of the contractor, the longitudinal joint of the nestable pipe sections shall be either Type I, flanged, or Type II, notched, as specified in MIL-P-236.

1010-6 Reinforced Concrete Pipe:

Reinforced concrete pipe (circular) shall conform to the requirements of AASHTO M 242 for the D-load specified.

Reinforced concrete pipe (circular) shall conform to the requirements of AASHTO M 170 for the class of pipe specified.

Reinforced concrete pipe (elliptical) shall conform to the requirements of AASHTO M 207 for the class of pipe specified.

Reinforced concrete pipe (arch) shall conform to the requirements of AASHTO M 206 for the class of pipe specified.

The contractor shall furnish the Engineer a copy of the pipe design when the standard AASHTO tables are exceeded.

Precast, reinforced concrete flared end sections shall conform to the requirements of the previously cited specifications to the extent to which they apply. The area of steel reinforcement per linear foot of the flared end section shall be at least equal to the minimum steel requirement for the reinforcement in that portion of the flared end section which abuts the pipe.

Gaskets for reinforced concrete pipe (circular) joints shall conform to the requirements of AASHTO M 198.

Mortar used to join reinforced concrete pipe shall be composed by volume of one part Portland cement, two parts fine aggregate, one-fifth part hydrated lime and sufficient water to provide a plastic mixture. Cement and water shall conform to the requirements of Section 1006.

Fine aggregate shall conform to the grading requirements of ASTM C 144. Hydrated lime shall conform to the requirements of ASTM C 207, Type N. The lime shall be considered as an addition to and not as replacement for any cement.

1010-7 Nonreinforced Concrete Pipe:

Nonreinforced concrete pipe shall conform to the requirements of AASHTO M 86 for the class of pipe specified.

Gaskets and mortar used to join nonreinforced concrete pipe shall conform to the requirements hereinbefore specified under Subsection 1010-6.

1010-8 Corrugated High Density Polyethylene Plastic Pipe:

Corrugated high density polyethylene plastic pipe, fittings, couplings and ends, where specified, shall conform to the requirements of AASHTO M 252 for pipe sizes less than 12 inches in diameter and AASHTO M 294 for pipe sizes 12 to 48 inches in diameter.

Non-perforated pipe shall have either water resistant or watertight joints, as specified on the project plans. Watertight joints may substitute or be used when water resistant joints are required.

Water resistant joints shall be watertight according to the requirements of ASTM D 3212, except that the internal water pressure test shall be conducted at 2.0 pounds per square inch, during which the joint leakage shall not exceed 200 gallons per inch of diameter per mile of pipe per day.

Watertight joints shall be watertight according to the requirements of ASTM D 3212.

Magnetic tape, which is to be placed in the trench with the corrugated high density polyethylene plastic pipe as an aid in location after burial, shall have a minimum overall thickness of 5.5 mils and a minimum tensile strength of 5,000 pounds per square inch.

1010-9 Metal Safety End Sections:

Metal safety end sections shall conform to the applicable requirements of AASHTO M 36.

Bolts and nuts shall be steel conforming to the requirements of ASTM A 307 and shall be galvanized in accordance with the requirements of ASTM A 153.

Safety and longitudinal bars shall be fabricated using schedule 40 galvanized pipe. All bars shall be galvanized after fabrication in accordance with the requirements of ASTM A 123. Components of bolted assemblies shall be galvanized after fabrication in accordance with the requirements of ASTM A 153 separately before assembly.

SECTION 1011 JOINT MATERIALS:

1011-1 Rubber Waterstops:

Rubber waterstops shall be either molded or extruded from plain rubber or synthetic rubber, at the option of the contractor.

The waterstops shall be formed with an integral cross section which shall be uniform within ± 1/8 inch in width and the web thickness or bulb diameter within + 1/16 and - 1/32 inch. No splices will be permitted in straight strips and special connection pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous and free from porosity or other defects. All junctions in the special connection pieces shall be full-molded. During the vulcanizing period the joints shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross section.

Field splices shall be vulcanized; mechanical, using stainless steel parts; or made with a splicing union of the same stock as the waterstop, at the option of the contractor. All finished splices shall have a tensile strength of not less than 50 percent of the unspliced material.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1011-1.01 Plain Rubber Waterstops:

Plain rubber waterstops shall be formed from stock composed of a high grade compound made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, anti-oxidants and softeners and shall conform to the following requirements:

New Plantation Rubber Content, by volume, percent	Minimum 72
Tensile Strength (ASTM D 412), psi	Minimum 3,500
Elongation at Breaking (ASTM D 412), percent	Minimum 550
Unit Stresses:	
At 300 percent Elongation, psi	Minimum 1,100
At 500 percent Elongation, psi	Minimum 2,800
Shore Durometer (Hardness) (ASTM D 2240)	55 to 65
Tensile Strength and Elongation at Breaking (ASTM D 572), after 7 days in air at 158 ± 2 ^{o}F or after 48 hours in oxygen at 158 ± 2 ^{o}F and 300 psi = percent of original	Minimum 65

1011-1.02 Synthetic Rubber Waterstops:

Synthetic rubber waterstops shall be formed from a compound made exclusively from neoprene or SBR (styrene butadiene rubber), reinforcing carbon black, zinc oxide, polymerization agents and softeners and shall conform to the following requirements:

Neoprene or SBR Content, by volume, percent	Minimum 70
Tensile Strength (ASTM D 412), psi	Minimum 2,500
Elongation at Breaking (ASTM D 412), percent	Minimum 425
Shore Durometer (Hardness) (ASTM D 2240)	50 to 70
Tensile Strength and Elongation at Breaking (ASTM D 572), after 7 days in air at 158 ± 2 ^{o}F or after 48 hours in oxygen at 158 ± 2 ^{o}F and 300 psi = percent of original	Minimum 65

1011-2 Polyvinyl Chloride (PVC) Waterstops:

Polyvinyl chloride waterstops shall be manufactured from virgin polyvinyl chloride conforming to the requirements of the Corps of Engineers Specification Number CRD-C572.

Certificate of Compliance conforming to the requirements of Subsection 106.05 shall be submitted stating that the requirements specified under paragraph six of CRD-C572 have been complied with.

Field splices shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. The heat shall be sufficient to melt but not char the plastic.

1011-3 Joint Sealant (Hot-Poured):

Joint sealant material shall be a one component, hot poured type, conforming to the requirements of either ASTM D 3406 or ASTM D 3569. Joint sealant shall not contain any coal-tar materials.

The following requirement shall be added to paragraphs 7.1 of ASTM D 3406 and 7.1 of ASTM D 3569:

> The minimum ambient temperature during application and ambient temperatures under various storage conditions shall be clearly marked on the container.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1011-4 Joint Sealant (Cold-Application):

Joint sealant shall be cold-application, mastic, single- or multiple-component type.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1011-5 Bridge Deck Joint Seals:

The elastomer for joint seal elements shall be polychloroprene rubber (Neoprene and shall be compatible with concrete and shall be resistant to abrasion, oxidation, aging and sunlight, and to oils, gasoline, salt and other materials that may be spilled on or applied to the surface.

Joint seals shall be of the cellular compression type or strip type.

One piece of the material supplied shall be at least 18 inches longer than required by the plans and the additional length will be removed by the Engineer and used for testing by ADOT Materials Group.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1011-5.01 Compression Seals:

Compression seals shall consist of a prefabricated preformed elastomer joint seal material and shall conform to the requirements of ASTM D 3542.

The seal shall consist of a multi-channel nonporous, homogeneous material furnished in a finished extruded form.

The minimum depth of the seal, measured at the contact surface, shall be at least 95 percent of the minimum uncompressed width of the seal as designated by the manufacturer.

The joint seal shall provide a Movement Rating (MR) of not less than that shown on the plans. The seal shall be so formed that it can be compressed to 40 percent of its original width without damage while simultaneously maintaining the top center of the exposed surface below the top surface of the installed joint.

The top and bottom edges of the joint seal shall maintain continuous contact with the side of the armor over the entire range of joint movement.

The compression seal shall be furnished full length except as otherwise specified on the project plans and as indicated on Standard Drawing B-24.20.

At all open ends of the seal that would admit water or debris, each cell shall be filled to a depth of three inches with commercial quality open cell polyurethane foam or closed by other means subject to the approval of the Engineer.

The seal element shall be installed in strict accordance with the manufacturer's recommendations, subject to these specifications and the approval of the Engineer, using equipment manufactured specifically for the installation of said element. The equipment shall not cause structural damage to either the seal element or the joint armor and shall not twist, distort, or cause other malformations in the installed seal element. Contact surfaces of the seal element shall be cleaned with normal butylacetate, using clean rags or mops, immediately prior to application of lubricant adhesive and sealant. The lubricant adhesive and sealant shall be applied to the seal element and joint armor contact surfaces at the rate recommended by the manufacturer.

If the required joint opening at the time of installation is inadequate to allow for easy installation of the seal element, the compression seals shall be shop installed into deck joint assemblies to be shipped fully assembled and installed as a unit. Fully assembled units shall have the lubricant adhesive applied to the seal and armor contact surfaces and shall be equipped with shipping and temperature adjustment devices approved by the Engineer.

The lubricant adhesive and sealant shall conform to the provisions of ASTM D 4070.

The lubricant adhesive and sealant shall have a viscosity such that it will perform suitably with installation equipment, remaining fluid from 5 degrees F to 120 degrees F.

Each lot of lubricant adhesive and sealant shall be delivered in sealed containers plainly marked with the manufacturer's name or trademark and the date of manufacture. The shipping containers shall also indicate any special precautions or instructions required because of product toxicity, flammability, or other such information pertinent to the proper storage and use of the product.

1011-5.02 Strip Seals:

Strip seals shall be preformed non-reinforced, polychloroprene strip seal glands that mechanically lock into steel retainers. The steel retainers shall be anchored into the structure in accordance with the contract requirements.

The adhesive lubricant used to install the strip seal gland into the locking steel retainer shall be a one part moisture curing polyurethane compound, meeting the requirements of ASTM D 4070.

The strip seal gland shall be delivered to the jobsite in lengths suitable for continuous one-piece installation for each individual expansion joint. Field splicing is not permitted.

All steel surfaces that come in contact with the strip seal gland shall be cleaned to meet the requirements of SSPC-SP6.

Special conditions such as mitres, tees, and crosses shall be shop fabricated in a mold under heat and pressure.

Strip seal gland installation at joint openings of less than 1-1/2 inches will not be permitted.

The elastomer for strip seal elements shall conform to the requirements of ASTM D 3542 modified as follows:

(a) Recovery testing is excluded

(b) TABLE 1 of ASTM D 3542 is revised as follows:

TABLE NO. 1
PHYSICAL PROPERTIES FOR PREFORMED ELASTOMER STRIP SEALS

Property	Requirement	ASTM Test Method
Tensile strength, minimum psi	2000	D 412
Elongation at break, min. %	250	D 412
Hardness, Type A durometer, points	60 ± 5	D 2240 (Modified) (1, 3)
Oven aging, 70 hr at 212 ^{o}F		D 573
Tensile strength, loss, max. %	20	
Elongation, loss, max. %	20	
Hardness, Type A durometer, points change	0 to + 10	D 2240 (Modified) (1, 3)
Oil swell, ASTM Oil No. 3, 70 hr at 212 ^{o}F, weight change, max. %	45	D 471
Ozone resistance, 20 % strain, 300 pphm in air, 70 hr at 104 ^{o}F	No Cracks	D 1149 (Modified) (2)
Low temperature stiffening 7 days at 14 ^{o}F; Hardness, Type A durometer, points change	0 to +15	D 2240 (Modified) (1, 3)
Compression set, 70 hr at 212 ^{o}F, maximum %	40	D 395 Method B (Modified) (1)

(1) The term "modified" in the table relates to the specimen preparation. The use of the strip seal as the specimen source requires that more plies than specified in either of the modified test procedures be used. Such specimen modification shall be agreed upon by the purchaser and producer or supplier prior to testing.
(2) Test in accordance with procedure A of ASTM D 518 and ozone concentration is expressed in pphm.
(3) The hardness test shall be made with the durometer in a durometer stand as recommended in ASTM D 2240.

1011-6 Preformed Expansion Joint Filler:

Preformed expansion joint filler for concrete structures, pavements and incidental items shall conform to the requirements on the plans. When not specified, one of the following joint fillers may be used.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1011-6.01 Bituminous Joint Filler:

Bituminous joint filler shall conform to the requirements of AASHTO M 213.

1011-6.02 Nonbituminous Joint Filler:

Nonbituminous joint filler shall conform to the requirements of AASHTO M 153, Type II, with the following modifications. The joint filler may be formed as a premolded strip from suitable fibers. The compression test specimen of the premolded fiber joint filler shall recover to at least 65 percent of its thickness before testing.

1011-7 Cellular Plastic Joint Filler:

Cellular plastic joint filler shall conform to the requirements of ASTM D 3204. The lubricant-adhesive shall be furnished by the manufacturer and used according to its recommendations.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1011-8 Silicone Joint Sealant:

1011-8.01 Testing:

Silicone joint sealant shall be a low modulus silicone that is specifically formulated to seal Portland cement concrete pavement joints. Silicone sealant shall be furnished in a one part formulation which is non-acid curing and shall meet the following physical requirements:

Test Method	Test	Materials Requirements
ASTM D 412 (Method A, Die C)	Tensile Stress at 150 % Elongation (1)	45 psi maximum
ASTM D 412 (Method A, Die C)	Elongation (1)	700% minimum
ASTM C 603	Extrusion Rate (ASTM C 920, Type S, Grade NS)	25 seconds maximum
ASTM D 792 (Method A)	Specific Gravity	1.15 - 1.515
ASTM C 679	Tack Free Time	120 minutes maximum
ASTM D 2240 (Shore A)	Durometer Hardness	25 maximum
ASTM C 719 (Mortar Block)	Movement (2)(3)	+50% and -50% of the joint width (4)
Notes:		

Test Method	Test	Materials Requirements
(1) Sample cured 7 days at 77 ± 2 ^{o}F and 50 ± 5% relative humidity. (2) Curing of specimens shall be accordance with Article 8.2; any option or alternate conditions will not be permitted. (3) Section 9, Procedure, shall be strictly adhered to through and including Article 9.5. The test procedure will then be considered concluded. (4) Adhesive loss maximum 15 % of surface area and no cohesive failure after 10 cycles at standard conditions.		

1011-8.02 Packaging and Marking:

The sealant shall be delivered in the manufacturer's original sealed container. Each container shall have attached, intact, the original manufacturer's label. The label shall be tamper-proof, non-removable and shall be legibly marked with the manufacturer's name, the trade name of the sealer, the manufacturer's batch or production lot number, and the expiration date of the manufacturer's shelf life warranty. Sealant that has exceeded the shelf life warranty expiration date shall not be used unless it has been retested and recertified for adhesion in conformance with ASTM C 719. The sealant may be recertified for a period not exceeding six months from the date of retesting. Retesting or replacement of the sealant will be at the contractor's option. Retesting will be at no additional cost to the Department. Failure to meet specification requirements shall not be cause for claim or extension of the contract. The contractor shall be held liable for all costs incurred in procuring and testing of materials that are found to be outside specification requirements.

1011-8.03 Field Performance:

The manufacturer of the joint sealant shall demonstrate satisfactory field performance in Arizona of less than one percent total failure (either within the material or the adhesive bond to the joint face) after one year of service, before the material shall be used.

1011-8.04 Sampling:

All sealant to be used on the project shall be stockpiled at the site at least forty-five (45) working days prior to use, or at least sixty (60) working days prior to use if stockpiled at the vendor's place of business. This will allow thirty-five (35) days for laboratory testing to determine compliance. Subsequent deliveries shall be placed in separate stockpiles. The Engineer shall be notified when each stockpile has been established and is ready to be sampled. Not less than one random sample of each lot or batch number (minimum of 10 pounds per sample) shall be taken. No material shall be placed until the Engineer has approved the material for placement.

1011-8.05 Certification:

The contractor shall, at no additional cost to the Department, have the previously obtained sample tested by an independent laboratory. The testing laboratory shall be approved by the Engineer, shall be independent of the sealant manufacturer, and shall be under the supervision of a registered professional engineer. The contractor shall furnish to the

Engineer certification by the approved testing laboratory that the production lot tested meets the specified requirements. A Certificate of Compliance and Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted.

SECTION 1012 GUARDRAIL MATERIALS:

1012-1 General Requirements:

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted. In addition, Certificates of Analysis conforming to the requirements of Subsection 106.05 shall be submitted for High-Strength Anchor Bolts (3/4-inch) as listed in Table 1012-1.

References to ARTBA in this section shall mean the latest edition and supplements to the publication "A GUIDE TO STANDARDIZED HIGHWAY BARRIER RAIL HARDWARE", ARTBA Technical Bulletin No. 268-B.

1012-2 Fasteners, Elements, Posts and Blocks:

Guardrail fasteners shall conform to the requirements of Table 1012-1. Guardrail elements shall conform to the requirements of Table 1012-2. Metal guardrail posts and blocks shall conform to the requirements of Table 1012-3. Timber guardrail posts and blocks shall conform to the requirements of Subsection 1012-4.

All surfaces of guardrail elements which are exposed to traffic shall present a uniform, pleasing appearance and shall be free of scars, stains or corrosion.

1012-3 Miscellaneous Materials:

Nails shall be 16-penny common, galvanized. Nails for retainer strap shall be 10-penny common, galvanized.

Welded wire fabric for guardrail anchor assembly shall be 6x6-W2.9xW2.9 and shall conform to the requirements of AASHTO M 55.

Concrete for the guardrail anchor assemblies shall conform to the requirements of Section 1006 for Class S concrete of the strength shown on the plans.

The metal used to manufacture reflector tabs shall be either 3003-H14 aluminum strip 0.063 ± 0.004 inches thick, or steel strip 0.078 ± 0.008 inches thick galvanized in accordance with ASTM A 653 coating designation G 90. The reflector material shall be high-reflectivity sheeting, either silver-white or yellow and shall conform to the requirements of Section 1007. The reflective sheeting shall adhere to the metal tabs.

Nuts, bolts, and washers to be used in installations for which the details are not shown on the plans nor in the ARTBA publication shall conform to the requirements of ASTM F 568 or

A 307; be galvanized in accordance with the requirements of ASTM A 153, Class C; and conform to the dimensional requirements of the American National Standards Institute.

Structural steel shapes, plates, bars and strips used in fabrication of hardware and all miscellaneous steel shall conform to the requirements of ASTM A 36 and shall be galvanized in conformance with the appropriate requirements of AASHTO M 111 and M 232. They shall meet the dimensional requirements of The American Institute of Steel Construction.

Round and square structural steel tubing shall conform to the material requirements of either ASTM A 500 or A 501 and shall be galvanized in accordance with the requirements of AASHTO M 180, Type 1.

The tubular thrie beam shall be fabricated from thrie beam elements conforming to the requirements of ARTBA, RE-63, Class A, Type 1.

Concrete anchors shall be of the type indicated on the project plans. The self-drilling type shall be internally threaded and the stud type shall be externally threaded. Both types shall have an external slit expansion element and a single cone expander. Galvanizing shall be in accordance with the requirements of AASHTO M 232.

Where galvanizing has been damaged, the coating shall be repaired by painting with two coats of zinc paint, in accordance with Section 1002.

TABLE 1012-1
GUARDRAIL FASTENERS

Part Name	ARTBA Drawing No.	Specification
Button Head Bolt (5/8 inch) and Recess Nut	F - 3	AASHTO M 180
Hex Bolt		ASTM A 307
Heavy Hex Structural Bolt		ASTM A 325, Type 1
Hex Nut and Hex Thick Nut		ASTM A 563, Grade A
Heavy Hex Nut		ASTM A 563, Grade DH
Plain Washer (Type A) and Plain Washer (Wide) (Type A)		ASTM F 436
Plain Washer (Narrow) (Type A)	F - 45	
Rectangular Plate Washer	F - 12	AASHTO M 180, Class A, Type 1
Cable Assembly	F - 37	AASHTO M 30, Class C
Cable End Plate	F - 38	
Tapered Washer	F - 40	ASTM F 436
Bearing Plate	F - 41	
Flat Plate Washer	F - 43	ASTM F 436
Anchor Bolt	F - 44	
Hex Nut		ASTM A 563
Round Head Square Neck Bolt		ASTM F 568

TABLE 1012-2 GUARDRAIL FASTENERS		
Part Name	**ARTBA Drawing No.**	**AASHTO M 180 Designation**
W-Beam	RE - 3	Class A, Type 1
W-Beam Back-Up Plate	RE - 4	Class A, Type 1
W-Beam Terminal Connector	RE - 8	Class A, Type 1
Rub Rail	RE - 9	
Thrie Beam	RE - 63	Class A, Type 1
Thrie Beam Back-Up Plate	RE - 64	Class A, Type 1
Anchor Plate	RE - 71	

TABLE 1012-3 METAL GUARDRAIL POSTS AND BLOCKS		
Part Name	**ARTBA Drawing No.**	**Specification**
G4 and MB4 Structural Shape Post and Block	P - 10	
G4 and MB4 Bent Plate Post and Block (Steel)	P - 52	ASTM A 570, Grade 40
G9 and MB9 Structural Shape Post and Block	P - 54	
G9 and MB9 Bent Plate Post and Block (Steel)	P - 56	ASTM A 570, Grade 40
Terminal Post (Steel)	P - 60	ASTM A 500, Grade B
Terminal Post Foundation Plates (Steel)	P - 61	

1012-4 Timber Guardrail, Posts and Blocks:

Timber for posts and blocks shall be rough sawn (unplaned) or S4S with the nominal dimensions indicated. Any species or group of woods graded in accordance with the requirements for Timber and Posts of the Western Wood Products Association may be used.

Timber shall be No. 1 or better, and the stress grade shall be as follows:

6 inch by 8 inch Post and Block	1,200 psi
8 inch by 8 inch Post and Block	900 psi
10 inch by 10 inch Post and Block	900 psi

When the plans show guardrail systems using eight-inch by eight-inch timber posts and blocks, the contractor may use 8-1/4 inch by 8-1/4 inch nominal size posts and blocks with a stress grade of 825 pounds per square inch.

At the time of installation, the dimensions of timber posts and blocks shall vary no more than ± 1/2 inch from the nominal dimensions as hereinbefore specified.

The size tolerance of rough sawn blocks in the direction of the bolt holes shall vary no more than ± 3/8 inch. Only one type of post and block shall be used for any one continuous length of guardrail.

All timber shall have a preservative treatment in accordance with the requirements of AASHTO M 133.

SECTION 1013 BEARING PADS:

1013-1 Preformed Fabric Pads:

Preformed fabric pads shall be composed of multiple layers of eight-ounce cotton duck impregnated and bound with high quality natural rubber or of equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plies shall be such as to produce the specified thickness, after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10,000 pounds per square inch without detrimental reduction in thickness or extrusion.

Preformed fabric pad samples will be tested by the Department.

The manufacturer certification and sampling shall conform to the requirements of Subsection 1013-3.

1013-2 Elastomeric Bearing Pads:

1013-2.01 General:

The work shall consist of furnishing and installing elastomeric bearing pads. Bearings shall be constructed in accordance with the details shown on the plans and as specified in these specifications.

Prior to shipment from the point of manufacture, bearings shall be packaged in such manner to ensure that during shipment and storage the bearings will be protected against damage from handling, weather, or any normal hazard. All bearings shall be stored at the work site in an area that provides protection from environmental and physical damage. When installed, bearings shall be clean and free of all foreign substances.

Bearings shall be installed to the positions and orientations shown on the plans. Bearings shall be set level, in exact positions, and must have full and even bearing on all bearing planes. Bearings surfaces located at improper elevations or set not level and true to plane shall be corrected prior to placement of bearings. Elastomeric bearing pads shall be set directly on properly prepared concrete surfaces without bedding material.

Elastomeric bearing pads shall include unreinforced pads (consisting of elastomer only) and reinforced bearings with steel or fabric laminates.

Bearings shall be furnished with the dimensions, material properties and elastomer grade required by the plans. Unless otherwise specified on the plans, bearings which have thicknesses greater than 1/2 inch shall be reinforced with steel or fabric laminates. The design method (A or B) and the design load shall also be shown on the plans, and testing shall be performed accordingly. In the absence of more specific information, bearings shall be Grade 3, shall be an elastomer with 130 pounds per square inch shear modulus (55 durometer hardness), and shall be subjected to the load testing requirements corresponding to Method A design.

1013-2.02 Material Properties:

The sole polymer in the elastomeric compound shall be neoprene and shall be not less than 60 percent, by volume, of the total compound. The elastomer compound shall be classified as being of low temperature Grade 0, 2, or 3. The grades are defined by the testing requirements in Table 1013-1. A higher grade of elastomer, signified by a larger grade number, may be substituted for a lower one.

The elastomer compound shall meet the minimum requirements of Table 1013-1, except as otherwise specified by the Engineer. Test requirements may be interpolated for intermediate hardness. The material will be specified by its shear modulus whose measured value shall lie within 15 percent of the specified value. A consistent value of hardness shall also be supplied for the purpose of defining limits for the tests in Table 1013-1. Laminated bearings shall have a shear modulus not greater than 200 pounds per square inch. When test specimens are cut from the finished product, the physical properties shall be permitted to vary by 10 percent from those specified in Table 1013-1. All material tests shall be carried out at 73 ± 4 degrees F, unless otherwise noted. Shear modulus tests shall be carried out using the apparatus and procedures described in Annex A1 of ASTM D 4014.

Table 1013-1
NEOPRENE QUALITY CONTROL TESTS

Note that ASTM D 1043 refers to "modulus of rigidity" while ASTM D 4014 refers to "shear modulus." The word "stiffness" is used here to cover both terms.				
Physical Properties				
D 2240	Hardness: Shore A Durometer	45 to 75		
		50 ±5	60 ±5	70 ±5
D 412	Ultimate Elongation: min. %	400	350	300
	Tensile Strength: min. psi	2250		
Heat Resistance				
D 573: 70 hrs at 212 ^{o}F	Change in Durometer Hardness: maximum points	15		
	Change in Tensile Strength: maximum %	- 15		

Table 1013-1 NEOPRENE QUALITY CONTROL TESTS		
	Change in Ultimate Elongation: maximum %	 - 40
Compression Set		
D 395, Method B	22 hr at 212 ^{o}F: maximum %	 35
Ozone		
D 1149	100 pphm ozone in air by vol., 20 % strain, 100 ± 2 ^{o}F, 100 hr, mounting IAW ASTM D 518 (Procedure A)	 No Cracks
Low Temperature Brittleness		
D 746 Procedure B	Grade 0: No Test Required Grade 2: No Test Required Grade 3: Brittleness at - 40 ^{o}F	- - No Failure
Instantaneous Low Temperature Thermal Stiffening		
D 1043	Grade 0: Tested at - 25 ^{o}F Grade 2: Tested at - 25 ^{o}F Grade 3: Tested at - 40 ^{o}F	(1) (1) (1)
Low Temperature Crystallization		
Quad Shear Test As Described	Grade 0: No Test Required Grade 2: 7 Days at 0 ^{o}F Grade 3: 14 Days at - 15 ^{o}F	(2) (2) (2)
(1) Stiffness at test temperature shall not exceed four times the stiffness measured at 73 ^{o}F. (2) Stiffness at test time and temperature shall not exceed four times the stiffness measured at 73 ^{o}F with no time delay. The stiffness shall be measured with a quad shear test rig in an enclosed freezer unit. The test specimens shall be taken from a randomly selected bearing. A ± 25 % strain cycle shall be used, and a complete cycle of strain shall be applied with a period of 100 seconds. The first 3/4 cycle of strain shall be discarded, and the stiffness shall be determined by the slope of the force deflection curve for the next 1/2 cycle of loading.		

Certification, sampling and testing shall conform to the requirements of Subsection 1013-3.

1013-2.03 Plain and Fabric-Reinforced Elastomeric Bearing Pads:

Pads less than or equal to 1/2 inch in thickness shall be all elastomer. Pads greater than 1/2 inch thick shall be laminated. The stacking of individual laminated pads to attain thicknesses over 1/2 inch will not be permitted; however, cold bonding of individual laminated pads will be permitted providing the bond between the pads has a minimum peel strength of 20 pounds per inch of width.

Laminated pads shall consist of alternate layers of elastomer and fabric reinforcement bonded together. The top and bottom layers of reinforcement shall be uniformly covered with a layer of elastomer. The thickness of elastomer cover shall not vary.

Laminated pads shall have reinforcement every 1/2 inch through the entire thickness. Fabric reinforcement shall be single-ply at top and bottom surfaces of the pad and double-ply within the pad. Fabric shall be free of folds and ripples and shall be parallel to the top and bottom surfaces. Variations in the location of the reinforcement from its theoretical location in excess of the specified Fabrication Tolerances will be cause for rejection.

Pads of all-elastomer or with fabric reinforcement may be cut from large sheets. Cutting shall be performed in such a manner as to avoid heating of the material, to produce a smooth edge with no tears or other jagged areas, and to cause as little damage to the material as possible. The cutting method shall not cause any separation of the fabric from the elastomer for laminated bearings.

Flash tolerance, finish, and appearance shall meet the requirements of the latest edition of the Rubber Handbook published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings.

The bond between elastomer and fabric shall be such that when a sample is tested for separation, it shall have a minimum peel strength of 30 pounds per inch of width.

Fabric reinforcement shall be woven from 100 percent glass fibers of E-type yarn with continuous fibers. The minimum thread count in either direction shall be 25 threads per inch. The fabric shall have either a crowfoot or an 8 Harness Satin weave. Each ply of fabric shall have a breaking strength of not less than 800 pounds per inch of width in each thread direction when 3 inch by 36 inch samples are tested on split drum grips. The bond between double plies shall have a minimum peel strength of 20 pounds per inch of width. Holes in the fabric will not be permitted.

1013-2.04 Steel Reinforced Elastomeric Bearing Pads:

At the contractor's option, steel-reinforced elastomeric bearing pads may be furnished in lieu of fabric-reinforced elastomeric bearing pads that are 1/2 inch and over in thickness.

Steel-reinforced elastomeric bearing pads shall conform to the requirements for steel-laminated elastomeric bearings as specified in ASTM D 4014 and the following:

> The thickness of each bearing pad shall be as shown on the project plans. The bearings shall consist of (N-1) internal elastomer laminates and N steel laminates, where N is equal to the bearing pad thickness in inches shown on the project plans divided by 1/2 inch. The steel laminates shall be 14 gage and shall be spaced every 1/2 inch, center-to-center. The top and bottom steel laminates shall have 1/4 inch of elastomer cover as measured from the center of the steel laminate to the pad surface.

The elastomer clear cover thickness from the surface to the steel laminates at the sides of the bearings shall be 1/8 inch. If guide pins or other devices are used to control the side cover over the steel laminates, any exposed portions of the steel laminates shall be sealed by vulcanized patching.

Steel laminates used for reinforcement shall be made from rolled mild steel conforming to ASTM A 36, A 570, or A 611, Grade D. Holes in plates for manufacturing purposes will not be permitted unless they have been accounted for in the design, as shown on the plans.

Bearings with steel laminates shall be cast as a unit in a mold and shall be bonded and vulcanized under heat and pressure. The mold finish shall conform to standard shop practice. The internal steel laminates shall be sandblasted and cleaned of all surface coatings, rust, mill scale, and dirt before bonding, and shall be free of sharp edges and burrs. External load plates (sole plates) shall be protected from rusting by the manufacturer, and, preferably, shall be hot bonded to the bearing during vulcanization. Bearings that are designed to act as a single unit with a given shape factor must be manufactured as a single unit.

Steel laminated bearings shall develop a minimum peel strength of 40 pounds per inch of width.

1013-2.05 Fabrication Tolerances:

Plain pads and laminated bearings shall be built to the specified dimension within the tolerances listed in Table 1013-2.

Table 1013-2
FABRICATION TOLERANCES

Parameters	Tolerances	
	Minus	**Plus**
1. Overall Height:		
Design Thickness 1-1/4 inch or less	-0	+1/8 inch
Design Thickness over 1-1/4 inch	-0	+1/4 inch
2. Overall Horizontal Dimensions:		
36 inches or Less	-0	+1/4 inch
Over 36 inches	-0	+1/2 inch
3. Thickness of Individual Layers of Elastomer at any Point Within the Bearing	± 20 % of Design Value but no more than ± 1/8 inch	
4. Parallelism with Opposite Face:		
Top and Bottom	0.005 Radians	
Sides	0.02 Radians	
5. Position of Exposed Connection Members, Holes, Slots, or Inserts	± 1/8 inch	
6. Edge Cover: Embedded Laminates or Connection Members	-0	+1/8 inch

Table 1013-2 FABRICATION TOLERANCES		
Parameters	**Tolerances**	
	Minus	**Plus**
7. Thickness: Top and Bottom Cover Layer (if required)	-0	smaller of +1/16 inch and +20% of the nominal cover layer thickness
8. Size: Holes, Slots, or Inserts	± 1/8 inch	

1013-3 Certification and Testing:

1013-3.01 General Requirements:

(A) General:

A lot shall consist of a single type of bearing of the same design, material and thickness, delivered to the project site at the same time. Unless otherwise specified on the plans, certification and testing shall be as described in Subsections 1013-3.01(B) and (C).

(B) Testing by Manufacturer:

The contractor shall furnish the Engineer with Certificates of Analysis, conforming to the requirements of Subsection 106.05, from the manufacturer certifying that the bearings to be furnished conform to all specified requirements.

Each reinforced bearing shall be marked in indelible ink or flexible paint. The marking shall consist of the order number, lot number, bearing identification number, and elastomer type and grade number. The marking shall be on the face that is visible after erection of the bridge.

The ambient temperature tests on the elastomer described in Subsection 1013-3.02(A) shall be conducted for the materials used in each lot of bearings. In lieu of performing a shear modulus test for each batch of material, the manufacturer may elect to provide certificates from tests performed within the preceding year on identical formulations. Certificates of Analysis from the manufacturer shall be provided for each lot of reinforcement.

All three low temperature tests described in Subsection 1013-3.02(C) shall be conducted on Grade 3 material used in each lot of bearings, with the following exception. In lieu of the low temperature crystallization tests on each lot of bearings to be used, the manufacturer may choose to provide Certificates of Analysis from low-temperature crystallization tests performed within the preceding year on identical Grade 3 material.

Instantaneous thermal stiffening tests shall be conducted on material of Grades 0 and 2. Low temperature brittleness and crystallization tests are not required for Grade 0 or 2 materials.

Every finished bearing shall be visually inspected in accordance with Subsection 1013-3.02(D).

Every steel reinforced bearing shall be subjected to the short-term load test described in Subsection 1013-3.02(E).

From each lot of bearings designed by Method B of AASHTO Bridge Specifications Division I, Article 14.4, a random sample shall be subjected to the long-term load test described in Subsection 1013-3.02(F). The sample shall consist of at least one bearing chosen randomly from each size and material batch and shall comprise at least 10 percent of the lot. If one bearing of the sample fails, all the bearings of that lot shall be rejected, unless the manufacturer elects to test each bearing of the lot at no additional cost to the Department. In lieu of this random sampling procedure, the Engineer may require every bearing of the lot to be tested.

(C) Testing by Contractor:

A minimum of two sample pads from every 100 pads furnished, or portion thereof, will be selected at random by the Engineer at the project site for testing. A minimum of one sample pad will be selected from each lot. Samples shall consist of complete pads as detailed on the project plans and as specified herein. The contractor shall furnish additional complete pads to replace those taken for testing. Pads shall be available for testing at least three weeks in advance of intended use.

The contractor shall, at no additional cost to the Department, have the sample elastomeric bearing pads tested by a testing laboratory. The testing laboratory shall be approved by the Engineer, shall be not affiliated with the bearing pad manufacturer, and shall be under the supervision of a registered professional engineer. The contractor shall furnish the Engineer with Certificates of Analysis, conforming to the requirements of Subsection 106.05, from the approved testing laboratory certifying that the bearings tested conform to the specified requirements for dimensional tolerances and material properties. The following tests shall be performed as appropriate and be supported with Certificates of Analysis:

(1) Ambient temperature test
(2) Heat resistance test
(3) Low temperature test
(4) Visual inspection
(5) Shear modulus test
(6) Bond and peel strength tests

The heat resistance tests shall be performed in accordance with Subsection 1013-3.02(B).

Shear stiffness tests shall be performed on material from a random sample of the finished bearings in accordance with Subsection 1013-3.02(G).

Cold bonding of individual laminated pads and peel strength tests shall be performed in accordance with Subsection 1013-3.02(H).

1013-3.02 Testing Requirements:

(A) Ambient Temperature Tests on the Elastomer:

The elastomer used shall satisfy the limits prescribed in Table 1013-1 for durometer hardness, tensile strength, and ultimate elongation.. The bond to the reinforcement, if any, shall also satisfy the bond requirements in Subsection 1013-2.03 or 1013-2.04 and shall be tested in accordance with ASTM D 429, Method B. The shear modulus of the material shall be tested at 73 degrees F using the apparatus and procedure described in Annex A1 of ASTM D 4014. It shall fall within 15 percent of the specified value.

(B) Heat Resistance Tests on the Elastomer:

The elastomer shall satisfy the limits prescribed in Table 1013-1 for the change in durometer hardness, change in tensile strength, and change in ultimate elongation, as well as for compression set and ozone.

(C) Low Temperature Tests on the Elastomer:

Grade 3 elastomer shall be subjected to low temperature brittleness tests (ASTM D 746), instantaneous low temperature stiffness tests (ASTM D 1043), and low temperature crystallization tests (ASTM D 4014). Grades 0 and 2 elastomers shall be subjected to instantaneous low temperature stiffness tests (ASTM D 1043). The tests shall be performed in accordance with the requirements of Table 1013-1, and the compound shall satisfy all limits for its grade.

(D) Visual Inspection of the Finished Bearing:

Every finished bearing shall be inspected for compliance with dimensional tolerances and for overall quality of manufacture. In steel reinforced bearings, the edges of the steel shall be protected everywhere from corrosion.

(E) Short-Duration Compression Tests on Bearings:

The bearing shall be loaded in compression to 1.5 times its maximum design load. That load shall be held constant for five minutes, removed, and reapplied for another five minutes. The bearing shall be examined visually while under the second loading. If the bulging pattern suggests layer thickness or parallelism outside the specified tolerances or a poor laminate bond, the bearing shall be rejected. If there are three or more separate surface cracks greater than 0.08 inches wide and 0.08 inches deep, the bearing shall be rejected.

(F) Long-Duration Compression Tests on Bearings:

The bearing shall be loaded in compression to 1.5 times its maximum design load for a minimum period of 15 hours. If, during the test, the load falls below 1.3 times the maximum design load, the test duration shall be increased by the period of time for which the load is below this limit. The bearing shall be examined visually at the end of the test while it is still under load. If the bulging pattern suggests layer thickness or parallelism outside the specified tolerances or a poor laminate bond, the bearing shall be rejected. If there are three or more separate surface cracks greater than 0.08 inches wide and 0.08 inches deep, the bearing shall be rejected.

(G) Shear Modulus Tests on Material From Bearings:

The shear modulus of the material in the finished bearing shall be evaluated by testing a specimen cut from it using the apparatus and procedures described in Annex A1 of ASTM D 4014, or, if directed by the Engineer, a comparable nondestructive stiffness test may be conducted on a pair of finished bearings. The shear modulus shall fall within 15 percent of the specified value. If the test is conducted on finished bearings, the material shear modulus shall be computed from the measured shear stiffness of the bearings, taking account of the influence on shear stiffness of bearing geometry and compressive load.

(H) Bond and Peel Strength Tests:

Cold bonding between individual laminated pads, if used, shall be tested in accordance with the requirements of California Test 663.

The peel strength test shall be performed in accordance with ASTM D 429, Method B, for both fabric and steel reinforced pads.

1013-4 Installation:

Bearings shall be placed on surfaces that are plane to within 1/16 inch and horizontal to within 0.01 radians. Exterior plates of the bearing shall not be welded unless at least 1-1/2 inches of steel exists between the weld and the elastomer. In no case shall the elastomer or the bond be subjected to temperatures higher than 400 degrees F.

SECTION 1014 GEOSYNTHETICS:

1014-1 General Requirements:

Certificates of Compliance, conforming to the requirements of Subsection 106.05, shall be submitted to the Engineer by the contractor upon delivery of geosynthetic materials for use on a specific project. If the delivered materials have not been evaluated and preapproved as noted below, it will be necessary for a Certificate of Analysis to be submitted to the Engineer along with the supporting documentation before the material may be considered for use on the project. Each geosynthetic material lot or shipment must be approved by the Engineer before the materials may be incorporated in the work.

Certificates of Analysis, conforming to the requirements of Subsection 106.05, may be submitted, along with a representative sample of appropriate size for testing, by the supplier or manufacturer of any geosynthetic material to ADOT Materials Group for evaluation and preapproval. Testing methods and results shown in the Certificate of Analysis shall conform to the listed specifications for the proposed geosynthetic use. Supporting documentation including, but not limited to, product information sheets, installation procedures and recommendations, recommended use, and project references shall also be submitted by the supplier or manufacturer as part of product evaluation and preapproval.

Geosynthetic materials shall be furnished in protective covers capable of protecting the materials from harmful environmental conditions such as ultraviolet rays, abrasion, extreme heat, and water. Storage of the materials will be in a manner to prevent damage, contamination, or deterioration of the materials.

Samples of geosynthetic materials shall be submitted for testing. No samples shall be taken within five feet of either end of a roll. Samples shall be a minimum of three feet long by the full roll width. A minimum of one sample shall be taken per lot. More samples may be required as determined by the Engineer.

1014-2 Pavement Fabric:

Pavement fabric shall be a geotextile fabric material, constructed of nonwoven synthetic fibers of polyester or polypropylene. The pavement fabric shall be resistant to chemical attack, rot, and mildew, and shall have no tears or defects which will adversely alter its physical properties. The fabric shall be specifically designed for the designated pavement application, as a stress relieving membrane between two successive asphalt layers. The fabric material shall additionally conform to the following physical requirements:

Property	Requirement	Test Method
Weight: oz./sq. yd.	3.5 - 6.0	ASTM D 3776
Grab tensile strength: lbs.	80 minimum*	ASTM D 4632
Elongation at break: percent	50 minimum*	ASTM D 4632
Fabric thickness: mils	25 to 100	ASTM D 461
Melting point: degrees F	300 or greater	ASTM D 276
Asphalt Retention: gal./sq. yd.	0.2 mimimum	Task Force 25, Method 8
* Minimum - Average value in weaker principal direction. All numerical values represent minimum average roll values, i.e., the average test result in the weak direction for a lot shall meet or exceed the minimum values listed when sampled according to ASTM D 4354 and tested according to the test method specified above.		

The width of the fabric shall be appropriate for the proposed construction. Longitudinal fabric joints shall meet the same location requirements shown in Subsection 406-6 for pavement joints.

1014-3 Geogrid:

Geogrid reinforcement material for roadway base applications shall be a bi-axial polymer grid structure, specifically fabricated for use as a base reinforcement. The geogrid shall be one of the following structure types:

(A) A structure comprised of punched and drawn polypropylene or high density polyethylene sheet to form a grid.

(B) A structure comprised of high density polyethylene or polypropylene extruded to form a grid.

The geogrid shall have high tensile strength and modulus in both principal directions, perpendicular to each other. The geogrid polymer materials shall contain stabilizers or inhibitors or shall be coated or encapsulated to prevent degradation of properties due to ultraviolet light exposure. The polymer shall also be inert to all naturally occurring alkaline and acidic soil conditions. The geogrid material shall additionally conform to the following physical requirements:

Property	Requirement	Test Method
Average Aperture Size: inch		I.D. Calipered, (1)
MD, Note (2)	0.8 - 2.0	
XD, Note (3)	0.8 - 2.0	
Open Area: %	70 min., (4)	COE Method, (5)
Weight: oz./yd.	5.5 min.	ASTM D 3776
Thickness: mils		ASTM D 1777
At Rib	30 min.	
At Junction	60 min.	
Wide Width Strip Tensile Strength: lb./ft.		ASTM D 4595
At 2% Strain	275 min.	
At 5% Strain	550 min.	
At 15% Strain or Ultimate	800 min.	
Flexural Rigidity: mg-cm	250,000 min.	ASTM D 1388
Junction Strength: %	80 min.	ASTM D 638 Mod,(6)

(1) Maximum inside dimension in each principal direction measured by calipers.
(2) MD-Machine direction which is along roll length.
(3) XD-Cross machine direction which is across the roll width.
(4) Minimum - Average value in weaker principal direction. All numerical values represent minimum average roll values, i.e., the average test result in the weaker principal direction shall meet or exceed minimum values listed when sampled according to ASTM D 4354 and tested according to the test method specified above.
(5) Percent open area measured without magnification by the Corps of Engineers Method as specified in CW 02215, Civil Works Construction Guide, November 1977.
(6) Junction strength is measured as a percent of ultimate single rib strength by tensile loading test ASTM D 638 modified to clamp the horizontal and

Property	Requirement	Test Method
vertical ribs of a "T" shaped specimen, with the grid junction forming the cross of the "T", and with a constant rate of extension of the specimen applied across the junction at a rate of two inches per minute at a temperature of 68 degrees F.		

The width of the geogrid shall normally be approximately 13 feet or as appropriate for the proposed construction. Longitudinal geogrid joints shall meet the same location requirements shown in Subsection 406-6 for pavement joints.

1014-4 Separation Geotextile Fabric:

Separation geotextile fabric shall be a non-woven or woven fabric consisting only of long chain polymeric filaments such as polypropylene or polyester formed or woven into a stable network such that the filaments retain their relative position to each other. The fabric shall be inert to commonly encountered chemicals, resistant to rot and mildew, and shall have no tears or defects which adversely affect or alter its physical properties. The physical requirements for the separation fabric will be determined by the survivability rating called out for the fabric in the Special Provisions or as shown on the project plans. Physical requirements for nonwoven or woven fabrics for each survivability rating are listed in Subsections 1014-4.01, 1014-4.02, 1014-4.03, and 1014-4.04.

1014-4.01 Low Survivability Fabric:

(A) Nonwoven:

Low survivability, nonwoven separation fabric shall meet the following minimum average roll values:

Property	Requirement	Test Method
Grab Tensile Strength: lbs.	90	ASTM D 4632
Grab Elongation at Break: %	45 min., 115 max.	ASTM D 4632
Puncture Strength: lbs.	30	ASTM D 4833
Burst Strength: psi	130	ASTM D 3786
Trapezoidal Tear: lbs.	30	ASTM D 4533
Permittivity: $second^{-1}$	0.07	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 - 140	ASTM D 4751
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

(B) Woven:

Low survivability, woven separation fabric shall meet the physical requirements listed in Subsection 1014-4.02(A) for moderate survivability non-woven fabric except that the grab elongation at break, percent, shall be 13 minimum, 115 maximum.

1014-4.02 Moderate Survivability Fabric:

(A) Non-woven:

Moderate survivability, nonwoven separation fabric shall meet the following minimum average roll values:

Property	Requirement	Test Method
Grab Tensile Strength: lbs.	140	ASTM D 4632
Grab Elongation at Break: %	45 min., 115 max.	ASTM D 4632
Puncture Strength: lbs.	50	ASTM D 4833
Burst Strength: psi	210	ASTM D 3786
Trapezoidal Tear: lbs.	40	ASTM D 4533
Permittivity: $second^{-1}$	0.07	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

(B) Woven:

Moderate survivability, woven separation fabric shall meet the physical requirements listed in Subsection 1014-4.03(A) for high survivability nonwoven fabric except that the grab elongation at break, percent, shall be 13 minimum, 115 maximum.

1014-4.03 High Survivability Fabric:

(A) Nonwoven:

High survivability, nonwoven separation fabric shall meet the following minimum average roll values:

Property	Requirement	Test Method
Grab Tensile Strength: lbs.	200	ASTM D 4632
Grab Elongation at Break: %	45 min., 115 max.	ASTM D 4632
Puncture Strength: lbs.	75	ASTM D 4833
Burst Strength: psi	320	ASTM D 3786

Property	Requirement	Test Method
Trapezoidal Tear: lbs.	50	ASTM D 4533
Permittivity: second^{-1}	0.07	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

(B) Woven:

High survivability, woven separation fabric shall meet the physical requirements listed in Subsection 1014-4.04(A) for very high survivability nonwoven fabric except that the grab elongation at break, percent, shall be 13 minimum, 115 maximum.

1014-4.04 Very High Survivability Fabric:

(A) Nonwoven:

Very high survivability, nonwoven separation fabric shall meet the following minimum average roll values:

Property	Requirement	Test Method
Grab Tensile Strength: lbs.	270	ASTM D 4632
Grab Elongation at Break: %	45 min., 115 max.	ASTM D 4632
Puncture Strength: lbs.	110	ASTM D 4833
Burst Strength: psi	430	ASTM D 3786
Trapezoidal Tear: lbs.	75	ASTM D 4533
Permittivity: second^{-1}	0.07	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

(B) Woven:

Very high survivability, woven separation fabric shall meet the following minimum average roll values:

Property	Requirement	Test Method
Grab Tensile Strength: lbs.	340	ASTM D 4632
Grab Elongation at Break: %	13 Min., 115 Max.	ASTM D 4632
Puncture Strength: lbs.	130	ASTM D 4833
Burst Strength: psi	500	ASTM D 3786
Trapezoidal Tear: lbs.	90	ASTM D 4533
Permittivity: second^{-1}	0.07	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

1014-5 Bank Protection Fabric:

Geotextile fabric to be used behind bank protection such as rip rap, rail bank, or gabions as called out on the project plans shall be a woven monofilament fabric or nonwoven fabric consisting only of long chain polymeric filaments such as polypropylene or polyester formed into a stable network such that the filaments retain their relative position to each other. The fabric shall be inert to commonly encountered chemicals, resistant to rot and mildew, and shall have no tears or defects which adversely affect or alter its physical properties. The physical requirements for the bank protection fabric shall be as specified in Subsection 1014-4.03(A) except that the grab elongation at break, percent, shall be 15 minimum, 115 maximum, and the permittivity shall be 0.50 minimum.

1014-6 Geocomposite Wall Drain System:

The Geocomposite Wall Drain System shall be of composite construction, consisting of a supporting structure of drainage core material and a geotextile filter fabric permanently bonded to the core material on one side only. The geocomposite shall be resistant to commonly encountered chemicals and hydrocarbons, and resistant to ultraviolet exposure.

1014-6.01 Geocomposite Wall Drain Core:

The wall drain core material shall consist of a preformed, stable, polymer plastic material with a cuspated, nippled, or geonet structure. The drainage core shall provide support for and shall be bonded to the geotextile filter fabric at intervals not exceeding 1-1/8 inches in any direction. Its preformed structure shall be perforated to allow water to flow freely to the weephole drainage outlets. If not perforated during manufacture, the core shall be perforated in the field at the weephole drainage outlet locations. The core shall have at least 14 square inches per square foot of flat area in contact with the geotextile fabric to

support the fabric. The core material shall additionally conform to the following minimum physical requirements:

Property	Requirement	Test Method
Thickness with Fabric: inch	0.23 (1)	ASTM D 1777
Compressive Strength: psf	6,000	ASTM D 1621
Transmissivity; Gradient = 1.0, Normal Stress = 3000 psf, gal./min./ft.	4.0	ASTM D 4716
(1) Minimum average roll value, i.e., the average test result for a lot shall meet or exceed the minimum value listed when sampled and tested according to the specified test method.		

The geocomposite core shall be furnished with an approved method for connecting with outlet pipes or weepholes as shown on the plans. These fittings shall allow entry of water from the core, but shall not allow intrusion of backfill material into the core.

1014-6.02 Geocomposite Wall Drain Fabric:

The geotextile wall drain fabric shall be laminated onto or adhere to the side of the drainage core which will face the backfill. The geotextile fabric shall be a non-woven polyester or polypropylene fabric meeting the following minimum average roll values:

Property	Requirement	Test Method
Weight: oz./sq. yd.	3.5	ASTM D 3776
Grab Tensile Strength: lbs.	90	ASTM D 4632
Grab Elongation at Break: %	35 min., 115 max.	ASTM D 4632
Mullen Burst Strength: psi	140	ASTM D 3786
Trapezoidal Tear: lbs.	30	ASTM D 4533
Puncture Strength: lbs.	30	ASTM D 4833
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Permittivity: $second^{-1}$	0.50	ARIZ 730
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

A minimum three-inch wide flap of geotextile fabric shall extend beyond both longitudinal edges of the geocomposite core. The geotextile fabric shall cover the full length of the core.

1014-7 Geocomposite Edge Drain System:

The Geocomposite Edge Drain System shall be of composite construction, consisting of a supporting rectangular structure of drainage core material wrapped with a geotextile filter fabric. The fabric shall surround and be attached to the core material in a manner which does not restrict the flow capacity of the core material. The geocomposite shall be resistant to commonly encountered chemicals and hydrocarbons, and resistant to ultraviolet exposure.

1014-7.01 Geocomposite Edge Drain Core:

The edge drain core material shall consist of a preformed, stable, polymer plastic material with a cuspated, nippled, ridged, slotted, and/or perforated structure. The drainage core shall provide support for and may be bonded to the geotextile filter fabric. Its preformed structure shall be perforated to allow water to flow freely to the weephole drainage outlets. If not perforated during manufacture, the core shall be perforated in the field at the weephole drainage outlet locations unless otherwise approved by the Engineer. The core shall have at least 14 square inches of flat area in contact with the geotextile fabric to support the fabric per square foot. The core material shall additionally conform to the following minimum physical requirements:

Property	Requirement	Test Method
Thickness Wrapped with Fabric: inch	0.75 (1)	ASTM D 1777
Compressive Strength: psf	4,000	ASTM D 1621
Transmissivity; Fabric Wrapped Core, Gradient = 0.1, Normal Stress = 1500 psf, gal./min./ft.	4.0	ASTM D 4716, (2)
Width: ft.	1.0 (3)	Measured

Notes:
(1) Minimum average roll value, i.e., the average test result for a lot shall meet or exceed the minimum value listed when sampled and tested according to the specified test method.
(2) Use a full width panel, if possible, testing flow on the side which may be placed against the soil to be drained.
(3) Minimum width normally required, but shall be the minimum width specified on the plans, if that is greater.

1014-7.02 Geocomposite Edge Drain Fabric:

The geotextile edge drain fabric shall completely wrap around the drainage core material in a snug manner and may be permanently bonded to the core. The geotextile fabric shall be a non-woven polyester or polypropylene fabric meeting the following minimum average roll values:

Property	Requirement	Test Method
Weight: oz./sq. yd.	3.5	ASTM D 3776
Grab Tensile Strength: lbs.	90	ASTM D 4632

Property	Requirement	Test Method
Grab Elongation at Break: %	35 min., 115 max.	ASTM D 4632
Mullen Burst Strength: psi	140	ASTM D 3786
Trapezoidal Tear: lbs.	30	ASTM D 4533
Puncture Strength: lbs.	30	ASTM D 4833
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Permittivity: second^{-1}	0.50	ARIZ 730
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

1014-7.03 Outlet Pipes:

The pipe for the edge drain outlet lateral shall be rigid, four-inch diameter, Schedule 40 PVC pipe conforming to the requirements of ASTM D 1785, Schedule 40 polyethylene pipe conforming to the requirements of ASTM D 2104, or Schedule 40 ABS pipe conforming to the requirements of ASTM D 1527.

The open end of the outlet pipe conduit shall be connected into either a drainage structure or a concrete pad drain in accordance with the details shown on the plans.

1014-8 Temporary Silt Fence Fabric:

The geotextile silt fence fabric shall be a nonwoven or woven fabric consisting only of long chain polymeric filaments such as polypropylene or polyester formed or woven into a stable network such that the filaments retain their position relative to each other.

The fabric shall contain a stabilizer and/or inhibitors to make the filaments resistant to deterioration resulting from exposure to sunlight or heat.

The edges of the fabric shall be finished to prevent the outer yarn from pulling away from the fabric. The fabric shall be free of defects or flaws which significantly affect its physical or filtering properties. The fabric shall have a minimum width of 36 inches. Sheets of fabric may be sewn or bonded together. No deviation from any physical requirements will be permitted due to the presence of the seam.

The fabric may be manufactured with pockets for posts, hems with cord or with posts preattached using staples or button head nails.

During all periods of shipment and storage, the fabric shall be wrapped in a heavy duty protective covering which will protect the cloth from sunlight, mud, dust, and debris. The fabric shall not be exposed to temperatures greater than 140 degrees F.

The fabric shall meet the following average roll values:

Property	Requirement	Test Method
Grab Tensile Strength: lbs.	120 min.	ASTM D 4632
Elongation at 50 % of min. tensile strength (60 lb.): %	50 max.	ASTM D 4632
Permittivity: second^{-1}	0.05 min.	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 max.	ASTM D 4751
Ultraviolet Stability: %	70 min.	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above.

1014-9 Drainage Fabric:

Drainage geotextile fabric shall be used in the following applications: pavement edge drains, interceptor drains, underdrains, wall drains, recharge basins, and relief wells.

Drainage geotextile fabric shall be a non-woven fabric consisting only of long chain polymeric filaments such as polypropylene, polyethylene, or polyester formed into a stable network such that the filaments retain their relative position to each other. The fabric shall be inert to commonly encountered chemicals, resistant to rot and mildew, and shall have no tears or defects which adversely affect or alter its physical properties.

The physical requirements for the drainage fabric shall be as specified in Subsection 1014-4.02(A) for moderate survivability non-woven separation fabric except that the permittivity requirement for drainage fabric shall be 0.50 second^{-1}.

SECTION 1015 EPOXY MATERIALS:

1015-1 General Requirements:

Certificates of Compliance, conforming to the requirements of Subsection 106.05(B), shall be submitted to the Engineer by the contractor for any epoxy materials used on a specific project. The epoxy material must be on the current ADOT Approved Products List prior to submittal for use on an ADOT project. The epoxy material must be approved for the use or application for which it is intended.

The contractor shall submit product literature and Material Safety Data Sheets (MSDS). The literature shall identify the recommended product use or applications for which it is intended, and the directions for use.

1015-1.01 Packaging, Labeling and Storing:

Each component of epoxy material shall be packaged in containers of size proportional to the amount of that component in the mix so that one container of each component is used in mixing one batch of epoxy material.

The containers shall be of such design that all of the contents may be readily removed, and shall be well sealed to prevent leakage. The containers and labeling shall meet U.S. Department of Transportation Hazardous Material Shipping Regulations, and the containers shall be of a material, or lined with a material, of such character as to resist any action or breakdown by the components.

Each container shall be clearly labeled with the product type and identification code, component designation (A or B), manufacturer's name, date of manufacture, batch or lot number, all directions for use, and such warnings or precautions concerning the contents as may be required by State or Federal Laws and Regulations.

Epoxy materials shall be stored in accordance with the manufacturer's recommendations at all times. Attention is directed to the characteristic of some epoxy components to crystallize or thicken excessively prior to use when stored at temperatures below 35 degrees F. Any material which shows evidence of crystallization or a permanent increase in viscosity or settling of pigments which cannot be readily dispersed with a paddle shall not be used.

1015-1.02 Directions for Use:

Use of epoxy materials shall be in accordance with the manufacturer's recommendations unless otherwise specified by the Engineer. Use of epoxy materials shall be allowed for only those uses as shown on the ADOT Approved Products List.

At the time of mixing, the two components of the epoxy material shall be at a temperature between 60 and 85 degrees F, unless otherwise specified or approved by the Engineer. Any heating of the epoxy components shall be done by application of indirect heat.

Immediately prior to mixing, each component shall be thoroughly mixed with a paddle. Separate paddles shall be used to stir each component.

Immediately prior to use, the components of the epoxy materials shall be mixed together in the specified ratios according to the manufacturer's recommendations. When mixed, all epoxy materials shall have a uniform color without streaks. No solvent shall be added to any epoxy.

Surfaces on which the epoxy is to be placed shall be free of rust, paint, grease, asphalt and loose or otherwise deleterious materials. The surface shall be dry unless otherwise allowed according to the manufacturer's recommendations for use. Any overlay or inserted material which is to be bonded to the underlying surface shall be placed before thickening of the epoxy has begun.

When epoxy is used as a binder to make epoxy mortar, the components of the epoxy shall be thoroughly mixed together before the sand or fine aggregate is added. The type, gradation, and proportion of sand or fine aggregate added and mixed with the epoxy

adhesive to make epoxy mortar shall be as specified or recommended by the manufacturer. The sand or fine aggregate moisture content shall not be more than 0.5 percent as determined in accordance with AASHTO T 265. All surfaces against which epoxy mortar is to be placed shall be primed with a coat of the epoxy adhesive just prior to placing the epoxy mortar.

1015-2 Epoxy Resin Base Anchoring Adhesive:

Epoxy resin base anchoring adhesive shall be used in anchoring dowels or tie bars into concrete. For horizontal applications where flow out of the anchoring hole is a problem, high viscosity or non-sag epoxies in the form of a gel are to be used. Low and medium viscosity epoxies may be used in vertical holes which open upward. The product shall specifically be designed for this application according to the manufacturer's product literature.

Epoxy resin base anchoring material shall provide a minimum pullout resistance of 13,200 pounds when tested in accordance with Arizona Test Method 725. The pot life of the material shall be determined in accordance with AASHTO T 237, Part I. The pot life shall be within 25 percent or 10 minutes of the pot life specified by the manufacturer, whichever is greater.

1015-3 Epoxy Resin Base Adhesives:

(A) General:

The grade of the epoxy adhesive system shall match the proposed use as identified in the product literature provided by the manufacturer. The product shall specifically be designed for this application according to the manufacturer's product literature. The pot life of the material shall be determined in accordance with AASHTO T 237, Part I. The pot life shall be within 25 percent or 10 minutes of the pot life specified by the manufacturer, whichever is greater. Epoxies with high early strength development as stated by the manufacturer will be tested for conformance to the manufacturer's claims.

(B) Hardened Concrete to Hardened Concrete

Epoxy resin base adhesive to be used for adhering or bonding hardened concrete to hardened concrete and other materials shall conform to the requirements of ASTM C 881, Type I for non-load bearing applications and Type IV for load bearing applications. Epoxy resin base adhesive shall be tested in accordance with the requirements of ASTM C 882 and shall provide a slant shear compressive strength of 1,000 pounds per square inch at two days and 1,500 pounds per square inch at 14 days. The compressive strength shall be determined in accordance with ASTM C 109 for two-inch cube specimens except that the epoxy materials shall be tested without the addition of sand, and for low viscosity materials which readily flow, no tamping is necessary. The compressive strength determined at seven days shall be 8,000 pounds per square inch for Type I epoxy and 10,000 pounds per square inch for Type IV epoxy.

(C) Hardened Concrete to Fresh Concrete

Epoxy resin base materials to be utilized for adhering or bonding freshly mixed concrete materials to hardened concrete, shall conform to the requirements of ASTM C 881, Type II, for non-load bearing applications and Type V for load bearing applications. Epoxy resin base adhesive shall be tested in accordance with the requirements of ASTM C 882 and shall provide a slant shear compressive strength of 1,500 pounds per square inch at 14 days. The compressive strength shall be determined in accordance with ASTM C 109 for two-inch cube specimens except that the epoxy materials shall be tested without the addition of sand, and for low viscosity materials which readily flow, no tamping is necessary. The compressive strength determined at seven days shall be 5,000 pounds per square inch for Type II epoxy and 8,000 pounds per square inch for Type V epoxy.

1015-4 Epoxy Resin Base Binder for Epoxy Mortar:

Epoxy resin base materials to be used for binder in epoxy mortar, shall conform to the requirements of ASTM C 881, Type I, for non-load bearing applications and Type IV for load bearing applications. The grade of the epoxy adhesive system shall match the proposed use as identified in the product literature provided by the manufacturer. The product shall specifically be designed for this application according to the manufacturer's product literature.

Epoxy resin base adhesive for use as binder in epoxy mortar shall be tested in accordance with the requirements of ASTM C 882. In this test, the upper half of the slant shear test shall be molded epoxy mortar with the epoxy adhesive and sand or aggregate material mixed together as specified and in the proportions as recommended by the manufacturer. Prior to placing the epoxy mortar, the same epoxy adhesive shall be applied to the underlying concrete slant shear surface. The epoxy adhesive and mortar tested in this manner shall provide a slant shear compressive strength of 1,000 pounds per square inch at two days and 1,500 pounds per square inch at 14 days. The pot life of the mixed epoxy mortar shall be determined in accordance with AASHTO T 237, Part I. The pot life shall be within 25 percent or 10 minutes of the pot life specified by the manufacturer, whichever is greater. The compressive strength of the epoxy mortar shall be determined in accordance with ASTM C 109 for two-inch cube specimens. The epoxy material shall be tested with the addition of sand, mixed together as specified and in the proportions as recommended by the manufacturer. The compressive strength determined in this test at seven days shall be 8,000 pounds per square inch for Type I epoxy and 10,000 pounds per square inch for Type IV epoxy. Epoxies with high early strength development as stated by the manufacturer will be tested for conformance to the manufacturer's claims.

1015-5 Epoxy Resin Base Adhesive for Crack Repair:

Epoxy resin base materials to be used for crack repair in concrete, shall be furnished as two components which shall be mixed together at or just before the point of injection.

The epoxy resin base adhesive shall conform to the requirements of ASTM C 881, Type I, for use in non-load bearing applications and Type IV for use in load bearing applications. The grade of the epoxy adhesive system shall normally be Grade 1, low viscosity. Grade 2, medium viscosity epoxy adhesive systems may be used in larger width cracks. The product

shall specifically be designed for this application according to the manufacturer's product literature.

The epoxy resin base adhesive for crack repair shall be tested in accordance with the requirements specified in Subsection 1015-3(B).

Immediately prior to injection, usually at or near the injection tip, the two components shall be brought together as part of the injection process. The injection equipment and process utilized shall be in accordance with the manufacturer's recommendations. No solvents shall be utilized to thin the material.

SECTION 1016 PACKAGED DRY CONCRETE AND MORTAR MATERIALS:

1016-1 General Requirements:

Certificates of Compliance, conforming to the requirements of Subsection 106.05(B), shall be submitted to the Engineer by the contractor for any packaged dry concrete or mortar materials used on a specific project. The packaged dry concrete or mortar material must be on the current ADOT Approved Products List prior to submittal for use on the project, and must be approved for the application for which it is intended.

Packaged dry concrete and mortar materials shall be furnished premixed in a dry state including hydraulic cement, fine aggregate, coarse aggregate, and other ingredients as required for product performance. Only the addition of mix water shall be required at the site of the work.

The contractor shall submit product literature and Material Safety Data Sheets (MSDS). The literature shall identify the recommended product use or application for which it is intended and the directions for use.

1016-1.01 Packaging, Labeling and Storing:

The dry concrete or mortar material shall be packaged in suitable containers of such design that all of the contents may be readily removed, and shall be moisture resistant to prevent premature hydration of the hydraulic cement in the mixture. The containers and labeling shall meet the applicable U.S. Department of Transportation Material Shipping Regulations, and the containers shall be of a material, or lined with a material, of such character as to resist any action or breakdown by the components.

Each package or container shall be clearly labeled with the product name, type and identification code, manufacturer's name, date of manufacture, batch or lot number, and such warnings or precautions concerning the contents as may be required by State or Federal Laws and Regulations. Additional information shall be either marked on the package or attached to it. The additional information may include surface preparation requirements; mixing, placing and curing instructions; maximum amount of water to be used or maximum recommended consistency; recommended maximum usable working time

"pot-life" and approximate consistency at the end of that time; and the allowable temperature range for preparation and placement of the material.

Packaged dry concrete or mortar materials shall be stored in accordance with the manufacturer's recommendations at all times. Attention is directed to the characteristic of hydraulic cement materials to hydrate in the presence of moisture. Any material which shows evidence of hydration or does not appear suitable shall not be used.

1016-1.02 Directions for Use:

Use of packaged dry concrete or mortar materials shall be in accordance with the manufacturer's recommendations unless otherwise specified or limited by the Engineer. Use of packaged dry concrete or mortar materials shall be allowed for only those uses as shown on the ADOT Approved Products List.

At the time of mixing, the packaged dry concrete or mortar materials shall be at a temperature within the range allowed according to the manufacturer's recommendations unless otherwise specified or approved by the Engineer. Any heating of the dry materials shall be done by application of indirect heat. The manufacturer may permit, in the package instructions, adjusting the mixing water temperature to achieve temperature limitations imposed for use of the dry concrete or mortar materials.

Immediately prior to use, the mixing apparatus shall be clean, prewetted, and drained, and essentially free of hardened concrete, mortar, and other foreign material that can be removed with a trowel or with a hammer, using reasonable force. Water shall be added to the dry concrete or mortar mix materials and the materials shall be thoroughly mixed to the desired consistency according to the manufacturer's recommendations. When thoroughly mixed, the concrete or mortar mixture shall have a uniform color. The amount of mixing water may be varied to achieve the desired consistency for the proposed use; however, the maximum recommended amount of mixing water shall not be exceeded.

Surfaces on which the concrete or mortar material is to be placed shall be free of rust, paint, oil, grease, asphalt and loose or otherwise deleterious materials. The surface of existing concrete shall be roughened to ensure a good bond and shall be cleaned thoroughly with water, leaving existing concrete saturated, but free of standing water. An epoxy resin base adhesive may be required to bond the concrete or mortar material to the old concrete. Any overlay or inserted material which is to be bonded to the underlying surface shall be placed before the concrete patching material has begun to set.

The concrete or mortar materials may be drypacked, troweled, flowed, pumped or vibrated into place unless otherwise recommended by the manufacturer or specified herein. Use of an epoxy adhesive for bonding requires a dry surface unless otherwise recommended by the adhesive manufacturer. The method of placement depends on the application, but shall be in accordance with the manufacturer's recommendations.

1016-2 Packaged Dry High-Early Strength Concrete:

Packaged dry high-early strength concrete materials for use in building and repair jobs requiring a more rapid strength development, such as required for the earlier removal of forms, shall conform to the requirements of ASTM C 387.

The compressive strength of packaged high-early strength concrete material at three days shall be a minimum of 2,500 pounds per square inch. The compressive strength at seven days shall be a minimum of 3,500 pounds per square inch.

When placing the mixed high-early strength concrete against existing concrete for repair or patching applications, an epoxy resin base adhesive meeting the requirements of Subsection 1015-3 shall be applied to the surface of the existing concrete prior to placing the new concrete.

1016-3 Packaged Dry Normal Strength Concrete:

Packaged dry normal strength concrete materials for use in building and repair jobs where thicknesses exceed two inches, shall conform to the requirements of ASTM C 387, normal weight concrete. Typical uses include building or repairing sidewalks, steps, footings, and for setting posts.

The compressive strength of packaged normal strength concrete material at seven days shall be a minimum of 2,500 pounds per square inch. The compressive strength at 28 days shall be a minimum of 3,500 pounds per square inch.

When placing the mixed normal strength concrete against existing concrete for repair or patching applications, an epoxy resin base adhesive meeting the requirements of Subsection 1015-3 shall be applied to the surface of the existing concrete prior to placing the new concrete.

1016-4 Packaged Dry High Strength Mortar:

Packaged dry high strength mortar materials for use in work requiring thicknesses less than two inches shall conform to the requirements of ASTM C 387. Typical uses include topping and patching. High-strength mortar is often referred to as "sand mix."

The compressive strength (mortar cubes) of packaged high strength mortar material at seven days shall be a minimum of 3,000 pounds per square inch. The compressive strength at 28 days shall be a minimum of 5,000 pounds per square.

When placing the mixed high strength mortar against existing concrete for repair or patching applications, an epoxy resin base adhesive meeting the requirements of Subsection 1015-3 shall be applied to the surface of the existing concrete prior to placing the new mortar.

1016-5 Packaged Dry Rapid-Hardening Concrete:

Packaged dry rapid-hardening concrete materials for use in rapid repairs to hardened concrete shall conform to the requirements of ASTM C 928.

Aqueous solutions, emulsions or dispersions may be included as components of the packaged materials. The manufacturer may specify that these liquids are to replace some or all of the mixing water.

If the material contains soluble chlorides or other ingredients in sufficient quantity to cause corrosion to steel reinforcement, the material will not be acceptable.

The compressive strength of packaged rapid-hardening concrete material at three hours shall be a minimum of 500 pounds per square inch. The compressive strength at one day shall be a minimum of 2,000 pounds per square inch and at seven days the compressive strength shall not be less than 4,000 pounds per square inch. The strength at 28 days shall not be less than the strength at seven days.

Rapid-hardening concrete materials shall be tested in accordance with the slant shear requirements of ASTM C 882 by placing the test sample against a dummy section of hardened Portland cement mortar. The slant shear test samples prepared in this manner shall provide a slant shear compressive strength of 1,000 pounds per square inch at one day and 1,500 pounds per square inch at seven days.

The allowable length change of the rapid-hardening concrete material shall be determined in accordance with the requirements of ASTM C 157, except as modified in ASTM C 928, Sections 8.3 and 7.3. Based on the lengths of three-inch prisms at three hours, the allowable length increase after 28 days in water shall be less than + 0.15 percent. The allowable length decrease in air after 28 days shall be less than - 0.15 percent.

The rapid-hardening concrete shall have a slump of three inches at 15 minutes after addition of the mixing liquid. When placing the mixed rapid-hardening concrete against existing concrete for repair or patching applications, no adhesive or other bonding system will be necessary unless required by the manufacturer.

1016-6 Packaged Dry Very Rapid-Hardening Concrete:

Packaged dry very rapid-hardening concrete materials for use in rapid repairs to hardened concrete shall conform to the requirements of ASTM C 928.

Aqueous solutions, emulsions or dispersions may be included as components of the packaged materials. The manufacturer may specify that these liquids are to replace some or all of the mixing water.

If the material contains soluble chlorides or other ingredients in sufficient quantity to cause corrosion to steel reinforcement, the material will not be acceptable.

The compressive strength of packaged very rapid-hardening concrete material at three hours shall be a minimum of 1,000 pounds per square inch. The compressive strength at one day shall be a minimum of 3,000 pounds per square inch and at seven days the compressive strength shall not be less than 4,000 pounds per square inch. The strength at 28 days shall not be less than the strength at seven days.

Very rapid-hardening concrete materials shall be tested in accordance with the slant shear requirements of ASTM C 882 by placing the test sample against a dummy section of hardened Portland cement mortar. The slant shear test samples prepared in this manner shall provide a slant shear compressive strength of 1,000 pounds per square inch at one day and 1,500 pounds per square inch at seven days.

The allowable length change of the very rapid-hardening concrete material shall be determined in accordance with the requirements of ASTM C 157, except as modified in ASTM C 928, Sections 8.3 and 7.3. Based on the lengths of three-inch prisms at three hours, the allowable length increase after 28 days in water shall be less than + 0.15 percent. The allowable length decrease in air after 28 days shall be less than - 0.15 percent.

The very rapid-hardening concrete shall have a slump of three inches at five minutes after addition of the mixing liquid. When placing the mixed very rapid-hardening concrete against existing concrete for repair or patching applications, no adhesive or other bonding system will be necessary unless required by the manufacturer.

1016-7 Packaged Dry Rapid-Hardening Mortar:

Packaged dry rapid-hardening mortar materials for use in rapid repairs to hardened concrete shall conform to the requirements of ASTM C 928.

The packaged dry rapid hardening mortar material shall conform to the same requirements for rapid hardening concrete listed in Subsection 1016-5 except that the compressive strength shall be determined on mortar cubes, the length changes will be determined using one-inch prisms, and the consistency at 15 minutes after mixing will be a mortar flow of 100 percent, minimum.

1016-8 Packaged Dry Very Rapid-Hardening Mortar:

Packaged dry very rapid-hardening mortar materials for use in rapid repairs to hardened concrete, shall conform to the requirements of ASTM C 928.

The packaged dry very rapid hardening mortar material shall conform to the same requirements for very rapid hardening concrete listed in Subsection 1016-6 except that the compressive strength shall be determined on mortar cubes, the length changes will be determined using one-inch prisms, and the consistency at five minutes after mixing will be a mortar flow of 100 percent, minimum.

SECTION 1017 NONSHRINK GROUT MATERIALS:

1017-1 General Requirements:

Certificates of Compliance, conforming to the requirements of Subsection 106.05(B) shall be submitted to the Engineer by the contractor for any nonshrink grout materials used on a

specific project. The nonshrink grout material must be on the current ADOT Approved Products List prior to submittal for use on an ADOT project. The nonshrink grout material must be approved for the use or application for which it is intended and shall meet the requirements of CRD-C621-83, Corps of Engineers Specification For Nonshrink Grout, unless otherwise specified herein.

The contractor shall submit product literature and Material Safety Data Sheets (MSDS). The literature shall identify the recommended product use or application for which it is intended, and the direction for use.

Nonshrink grout materials shall be furnished premixed in a dry state including hydraulic cement, fine aggregate, and other ingredients as required for grout performance. Only the addition of mix water shall be required at the site of the work.

1017-2 Packaging, Labeling and Storing:

The nonshrink grout materials shall be packaged in suitable containers of such design that all of the contents may be readily removed, and shall be moisture resistant to prevent premature hydration of the hydraulic cement in the grout mixture. The containers and labeling shall meet the applicable U.S. Department of Transportation Material Shipping Regulations, and the containers shall be of a material, or lined with a material, of such character as to resist any action or breakdown by the components.

Each package or container shall be clearly labeled with the product name, type and identification code, manufacturer's name, date of manufacture, batch or lot number, and such warnings or precautions concerning the contents as may be required by State or Federal Laws and Regulations. Additional information shall be either marked on the package or attached to it. The additional information may include surface preparation requirements; mixing, placing and curing instructions; maximum amount of water to be used or maximum recommended consistency; unit weight and yield at maximum recommended water content or maximum consistency; recommended maximum usable working time, also called "pot-life," and approximate consistency at the end of that time; and the allowable temperature range for preparation and placement of the material.

Nonshrink grout materials shall be stored in accordance with the manufacturer's recommendations at all times. Attention is directed to the characteristic of hydraulic cement materials to hydrate in the presence of moisture. Any material which shows evidence of hydration or does not appear suitable shall not be used.

1017-3 Directions for Use:

Use of nonshrink grout materials shall be in accordance with the manufacturer's recommendations unless otherwise specified or limited by the Engineer. Use of nonshrink grout materials shall be allowed for only those uses as shown on the ADOT Approved Products List.

At the time of mixing, the nonshrink grout materials shall be at a temperature within the range allowed according to the manufacturer's recommendations unless otherwise

specified or approved by the Engineer. Any heating of the dry materials shall be done by application of indirect heat. The manufacturer may permit, in the package instructions, adjusting the mixing water temperature to achieve temperature limitations imposed for use of the grout materials.

Immediately prior to use, the grout mixing apparatus shall be clean, prewetted, and drained, and essentially free of hardened grout and other foreign material that can be removed with a trowel or with a hammer, using reasonable effort. Water shall be added to the grout materials and the grout shall be thoroughly mixed to the desired consistency according to the manufacturer's recommendations. When thoroughly mixed, the nonshrink grout mixture shall have a uniform color. The amount of mixing water may be varied to achieve the desired consistency for the proposed use; however, the maximum recommended amount of mixing water shall not be exceeded.

Surfaces on which the nonshrink grout material is to be placed shall be free of rust, paint, oil, grease, asphalt and loose or otherwise deleterious materials. The surface of existing concrete shall be roughened to ensure a good bond and shall be cleaned thoroughly with water, leaving existing concrete saturated, but free of standing water. Any overlay or inserted material which is to be bonded to the underlying surface shall be placed before the nonshrink grout material has begun to set.

The nonshrink grout materials may be drypacked, troweled, flowed, pumped or vibrated into place unless otherwise recommended by the manufacturer. The method of placement depends on the application, but shall be in accordance with the manufacturer's recommendations.

1017-4 Nonshrink Grout Material Requirements:

Nonshrink grout materials placed against existing concrete shall be tested in accordance with the slant shear requirements of ASTM C 882 by placing nonshrink grout against a dummy section of hardened Portland cement mortar. The slant shear test samples prepared in this manner shall provide a slant shear compressive strength of 1,000 pounds per square inch at seven days and 1,500 pounds per square inch at 28 days.

The Vicat time of set for the material shall be determined in accordance with AASHTO T 131. The time of set shall be within 25 percent or 10 minutes of the time of set specified by the manufacturer, whichever is greater. The time of final setting shall be a maximum of eight hours.

The compressive strength shall be determined in accordance with the requirements of CRD-C621-83, Corps of Engineers Specification For Nonshrink Grouts. The minimum compressive strength at seven days shall be 2,500 pounds per square and the minimum compressive strength at 28 days shall be 5,000 pounds per square inch. Nonshrink grouts with high early strength development as stated by the manufacturer will be tested for conformance to the manufacturer's claims. The compressive strength of nonshrink grout material at 28 days shall be equal to or greater than the 28 day compressive strength requirement of the concrete to be patched.

The expansion percent for the nonshrink grout material shall be determined in accordance with the requirements of CRD-C621-83. The maximum expansion shall be 0.4 percent when measured at 3, 14, and 28 days. The percent shrinkage at 28 days shall be none.